

BULLETIN OF THE RESEARCH COUNCIL OF ISRAEL

Section D BOTANY

Bull. Res. Council of Israel. D. Bot.

Continuing the activities of the
Palestine Journal of Botany,
Jerusalem and Rehovoth Series

This volume is dedicated to

PROFESSOR TSCHARNA RAYSS

on the occasion of her 70th birthday

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PROFESSOR TSCHARNA RAYSS

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PROFESSOR TSCHARNA RAYSS has been the Head of the Laboratory for Thallophyta of the Department of Botany of the Hebrew University of Jerusalem since 1934. With her quiet and modest character and with her particular personal charm, she has won the great love and esteem of her many students to whom she devoted the best of her time and knowledge. She always saw in teaching and in the guidance of students an aim of major importance. Her understanding of the personal problems of each and every one, lead to close ties between her and those who worked with her.

Prof. Rayss' name is known also far beyond the borders of Israel. Each year she is invited to participate in various scientific symposia and congresses. She has been appointed a Corresponding Member of the National Association for Natural Science and Mathematics of Cherbourg, and The Journal *Mycopathologia et Mycologia Applicata* published her photograph as one of the first in a series of important mycologists.

Before she came to Israel, Prof. Rayss was a lecturer at the University of Bucharest, and Vice-Director of the Department of Phytopathology in the Agricultural Research Institute in Rumania. She was then also a visiting lecturer at the University of Clermont-Ferrand in France. Even after she came to Israel she served for two years as a visiting lecturer at the University of Caen in France.

Her many research works cover the various fields in the world of lower plants. In algology, she has published papers on the algae of plankton, the algae of the hot springs of Kallirhoe, on the algae of the Mediterranean and Red Sea coasts, and others.

In the field of mycology, she has published papers on the classification as well as on the biology of the Fungi in Rumania and France. Her main work in this field, however, was carried out in Israel, and she has contributed a great deal to the knowledge of the mycoflora of Israel in its many groups, on which she has published tens of papers which deal with almost all fields of mycology. Prof. Rayss devoted herself to the study of these lower plants not only in the laboratory, but she untiringly made many excursions to all parts of the country, always happy for a chance to collect and study the Thallophyta in their natural habitats—sea, pond, lake, field, forest or desert. The material gathered in these excursions was studied and incorporated in the Thallophyta Herbarium in the Department of Botany which is outstanding for its richness of specimens, scientific accuracy and exemplary order. This Herbarium includes likewise many type specimens from various countries of the world with whom Prof. Rayss has exchange arrangements. Her meticulous and devoted work are everywhere felt in this Herbarium.

She never tired of extending her help and advice to all who asked for it. Her book on algae in fish ponds written in popular language is a great help to fish breeders. Likewise, the mushroom growers highly respect and appreciate her, since she spared no trouble to study different problems which arose in connection with growing cultivated mushrooms for food. Prof. Rayss also advises teachers and nature lovers who turn to her from all corners of the country.

Prof. f. Rayss devoted her whole life to her scientific work and to her many students. To-day she can be proud of the scientists she raised, and who themselves now hold key positions in various institutions in Israel.

With this appreciation, I wish to convey the admiration and deep love which all feel towards this modest woman. It is my every wish that she should for years continue to succeed in all that she undertakes.

Prof. F.S. Bodenheimer *

* This appreciation was submitted by Prof. Bodenheimer in the summer of 1959, for publication in this special issue of our Journal. Unfortunately, Prof. Bodenheimer passed away in London in October 1959.

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QUELQUES ALGUES D'EAU DOUCE DE LA REGION DE KONAKRY

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ABSTRACT

A collection of filamentous algae from a brackish swamp in the environs of Konakry (West Africa) was studied. A variety of *Arthrodesmus*, a species of *Staurastrum*, and a species and variety of *Temnogametum* are described. The zygote of the two latter taxa shows a sigmoid dehiscence line of a very singular type.

RESUME

L'auteur étudie une récolte d'algues d'eau douce de l'Afrique occidentale et décrit une variété nouvelle d'*Arthrodesmus*, une espèce nouvelle de *Staurastrum*, une espèce nouvelle de *Temnogametum*. Ces deux derniers taxa ont des zygotes avec ligne de déhiscence sigmoïde de type très particulier.

Le Professeur Roger Heim que nous remercions bien vivement nous a transmis une récolte d'algues filamenteuses provenant d'un marais des environs de Konakry. L'examen microscopique nous a montré une Zygnématacée fertile très abondante accompagnée de quelques rares Desmidiacées et de Diatomées en petit nombre. Notre surprise a été grande de constater qu'il s'agissait surtout d'espèces ou de variétés nouvelles.

Nous avons pu déterminer les espèces suivantes:

DIATOMEES: *Eunotia monodon* var. *tropica* Hustedt et *E. robusta* Ralfs.

OEDOGONIALES: *Oedogonium itzigsohnii* var. *minus* West (Figures 8-9) Il s'agit d'une forme à filaments très grêles de 5.5 à 6μ de diamètre, à oospore de $13\mu \times 16\mu$ contenue dans un oosporange à 8 appendices atteignant 30μ de diamètre.

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CONJUGALES: *Cylindrocystis brebissonii* Menegh. (TR); *Hyalotheca mucosa* v. *minor* Roy et Biss. (TR); *Arthrodesmus gibberula* Joh. v. *africana* var. nov. (AC); *Staurationum rayssiae* nov. sp. (AC), enfin *Temnogametum rayssiae* sp. nov. (Masse) et *Temnogametum indicum* var. *africanum* var. nov. (TR)

***Arthrodesmus gibberula* Joshua var. *africana* var. nov. (Figures 1 à 3)**

Differt a forma typica cellulis minoribus, spinis robustioribus, minoribus et obtusis.

Longit. 25μ , lat. sine aculeo $25-26\mu$, lat. cum spinis $28-34\mu$, crassit. 16μ , lat. isthmi $9-10\mu$.

Hab. ad "Konakry" (Guinea, Africae occ.).

Les 2 hémisomates sont à contour elliptique, un peu anguleux avec la marge apicale plate ou légèrement déprimée, ils se prolongent latéralement par une épine pleine, courte, à terminaison arrondie. Les épines des deux hémisomates convergent les unes vers les autres et se touchent presque. Le sinus est aigu, très refermé, la vue apicale montre un contour rhombique avec un épaississement interne de la membrane. Chaque hémisomate présente un seul pyrénioïde; la membrane est distinctement scrobiculée.

Les cellules mesurent $25\mu \times 25-26\mu$ sans les épines, leur largeur avec les épines varie de 28 à 34μ , l'épaisseur en vue polaire est de 16μ , l'isthme a 9 à 10μ .

Cette variété nouvelle est de plus petite taille que le type tel qu'il a été revu et figuré par les West (1902) mais il s'en distingue surtout par ses épines obtuses, courtes et puissantes.

L'espèce type est connue de l'Inde, Ceylan, la Malaisie; une variété a été signalée en Australie.

***Staurationum rayssiae* sp. nov. (Figures 4 à 7)**

Cellulae mediocres, duplo latiores quam longae, in medio incisura aperta leviter constrictae, semi-cellulae cyathiformes, processus longus convergentesque productae. Membrana sub apicem verrucis bidentatis 3 ornata, latera apicalia processuum denticulata, ad basim spinis undulatis instructa; extremitates processuum trispinatae. A vertice visum anguste fusiforme in medio incrassatum.

Long. $26-28\mu$, lat. cum processu $42-50\mu$, crass. $16-17\mu$, isthmo 8μ .

Zygotis globosis, aculeis longis, rectis, 3-4 furcis praeditis: 35μ cum aculeo.

Hab. ad "Konakry" (Guinea, Africae occ.).

Les hémisomates en vue frontale se prolongent en bras arqués, terminés par 3 dents. La marge apicale est denticulée, elle présente 5 à 6 épines droites sur chaque bras, tandis que la partie médiane offre 3 verrues bifides. La marge interne des bras

* Nous sommes heureux de dédier ces nouvelles espèces de *Staurationum* et de *Temnogametum* au Professeur T. Rayss en respectueux hommages.

est lisse et les deux hémisomates se raccordent par cette marge, en formant un isthme bien marqué; la partie basale de l'hémisomate est en coupe évasée. L'isthme est dépourvu de toute ornementation mais la plage préisthmale montre un épaississement en tumeur saillante bien marquée.

La vue apicale offre une partie centrale tumide, rhombique, ornée de 2 séries de 3 verrues bifides. Les bras sont droits et portent 5 ou 6 séries de une ou 2 épines droites; la première de ces séries est toujours de 2 épines. La vue de profil est concave à l'apex. Les cellules mesurent de 26 à 28μ de long pour une largeur de 42μ à 50μ ; l'isthme atteint 8μ .

Le zygote est du type banal, sphérique, de 25μ de diamètre et de couleur brun-olive pouvant aller jusqu'au noir. Il est orné d'épines rayonnantes, bifurquées à leurs sommets. L'ensemble du zygote et de ses épines atteint un diamètre de 35μ .

Cette nouvelle espèce peut se rapprocher de *St. assurgens* Nordst. (1888) et de sa var. *victoriense* G.S. W. Mais cette espèce et sa variété sont de plus grande taille et possèdent une ornementation apicale plus développée, de plus la marge du corps des hémisomates est denticulée.

Le *St. cyathipes* Scott et Grönblad (1957), forme voisine de grande taille, a lui aussi un apex très orné avec 8 à 10 verrues tridentées et ne possède pas la tumeur renflée médiane de *St. rayssiae*.

Temnogametum rayssiae sp. nov. (Figures 10 à 16)

Cellulae vegetativae $35-40\mu$ latae, 4-6-plo longiores quam latae, chloroplastum singulum axile, laminaeform, pyrenoideis 6-8 irregulariter dispositis in seriem duplicem; conjugatio scalariformis, zygosporae irregulariter elliptico-ovoideae in gametangiis quadrangularibus $47-80\mu \times 30-50\mu$; zygosporarum parietes 3-seriati; exosporium laeve vel irregulariter rugosum, mesosporium fuscescens, subtiliter scrobiculatum; linea rupturae in parietibus zygosporarum sigmoidea. Hab. ad "Konakry" (Guinea, Africae occ.).

Les cellules vegetatives observées, qui mesurent de 35 à 40μ de diamètre pour une longueur de 150 à 200μ , avaient un plaste désorganisé, car tous les filaments étaient à des stades plus ou moins avancés de conjugaison. Un examen après l'action de la solution de Lugol permet de reconnaître, sans certitude absolue, un plaste en lame portant deux séries parallèles de 6 à 8 pyrénoides chacune.

A la conjugaison, les gamétanges, fort courts, s'individualisent à une extrémité de la cellule végétative et la copulation, toujours scalariforme, se produit.

Les zygotes de forme et de taille assez variables, ellipsoïdaux ou réniformes, atteignent: $47-80\mu \times 30-50\mu$; ils restent enfermés dans les gamétanges très amples; l'espace entre zygote et gamétange est occupé par une gelée incolore et homogène. Une coloration au rouge de ruthenium, dans les zygotes jeunes, permet de reconnaître la structure zonée de cette gelée.

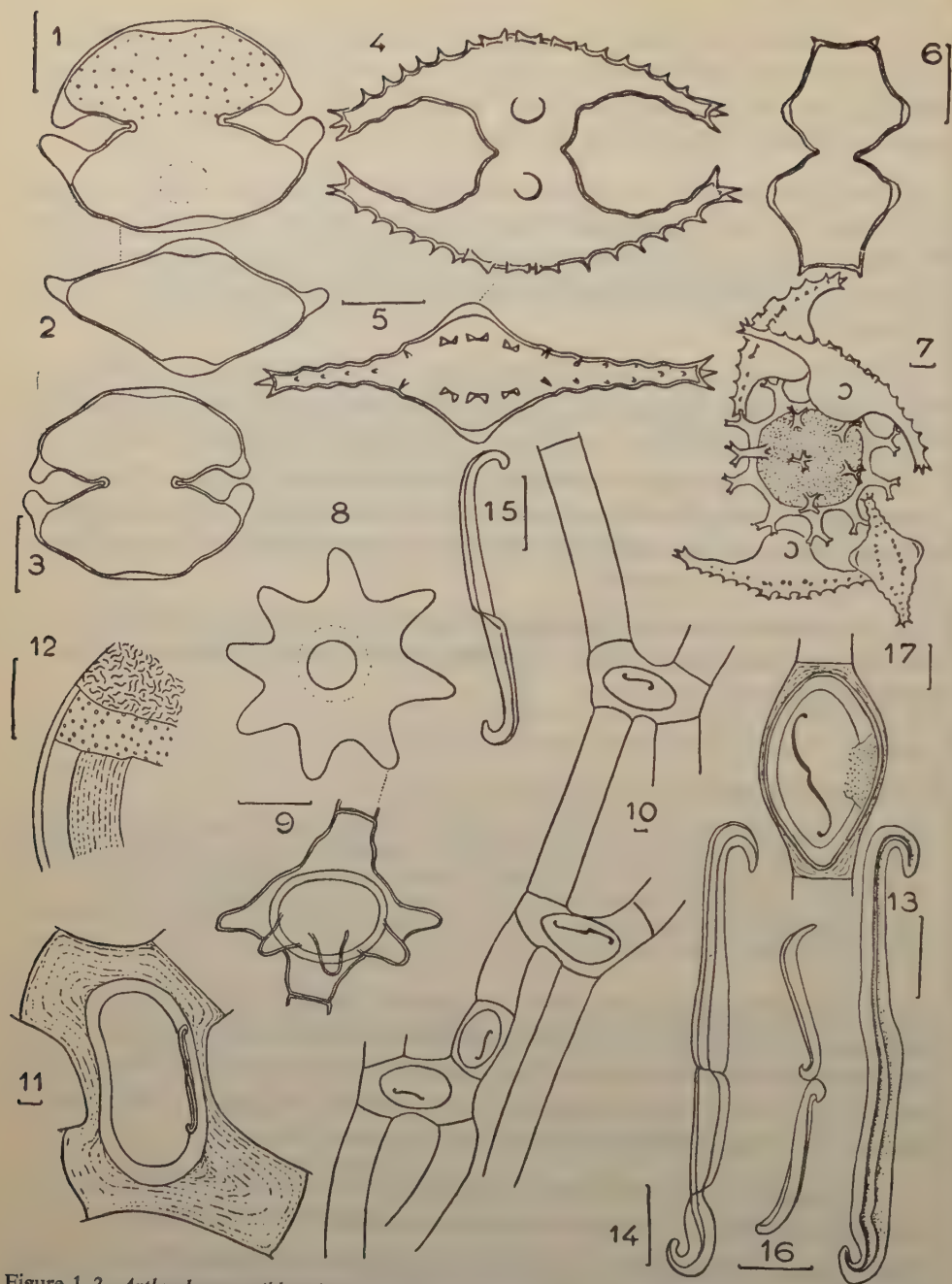


Figure 1-3. *Arthrodesmus gibberula* var. *africana* var. nov. 1, 3, vues frontales; 2, vue apicale. — Figures 4-7. *Staurastrum rayssiac* sp. nov. 4, frontale; 5, vue apicale; 6, coupe schématique de profil; 7, zygospore. — Figures 8-9. *Oedogonium itzigsohnii* var. *minus* West 8, vue frontale de l'oogone; 9, vue apicale de l'oogone. — Figures 10-16. *Temnogametum raysiac* sp. nov., 10, vue d'ensemble; 11, une zygospore; 12, détail du zygote; 13-16, fentes de déhiscence de diverses formes; 13-14, la même fente mise au point de surface (13), en vue plus profonde (14). — Figure 17. *Temnogametum indicum* (?) var. *africanum* var. nov.

(Le trait placé au voisinage du No. de la figure représente 10 μ).

Le zygote a une paroi épaisse de 10–12 μ . L'exospore est incolore ou jaune pâle, lisse, ou le plus souvent, crevassée, méandrique. La mésospore, jaune ou brune, est finement scrobiculée, l'endospore reste incolore, gélatineuse, rarement à striation parallèle. Le caractère le plus frappant de ces zygotes c'est la présence d'une ligne de déhiscence sigmoïde. Cette ligne, de longueur variable, est une fente dont la structure rappelle celle du raphé des *Pinnularia* du groupe des Complexae. Il s'agit d'une fente en forme de S, fente oblique par rapport à la surface du zygote dont l'obliquité change en général au milieu de son parcours.

Dans un récent travail Iyengar (1958) a décrit trois nouvelles espèces de *Temnogametum* de l'Inde qui présentent, elles aussi, une fente de déhiscence sigmoïde du même type que celle que nous venons de décrire.

À côté des zygotes nous avons observé des spores réalisées sans copulation et qui sont des aplanospores ou des parthénospores: elles ont la même structure que les zygospores.

Cette nouvelle espèce est à rapprocher de *T. indicum* Iyengar, mais taille des cellules et forme du zygote permettent de séparer facilement les deux espèces. *T. rayssiae*, par le diamètre des filaments rappelle *T. thaxteri* Transeau, mais la forme du zygote, sa taille, la ligne de déhiscence sigmoïde, constituent un bon ensemble de caractères distinctifs.

***Temnogametum indicum* (?) var. *africanum* var. nov. (Figure 17)**

Differt a forma typica cellulis minoribus, 12–13 μ lat.; chloroplastum laminaeforme, pyrenoideis 6–8 dispositis in linea unica; conjugatio abest; azygospora elliptico-ovoidea, long. 47 μ , lat. 28 μ , structura formae typice simili.

Hab. ad "Konakry" (Guinea, Africae occ.).

Cette espèce forme des filaments végétatifs minces, de 12 à 13 μ de diamètre pour 180 μ de longueur, avec un plaste en plaque portant 6 à 8 pyrénoides. Nous ne l'avons trouvé qu'en très petite quantité, et presque toujours stérile. Nous n'avons pu examiner qu'une seule spore (aplanospore ou parthénospore) de 28 \times 47 μ , emplissant presque entièrement le sporange. Cette spore à contour elliptique avait une exospore mince, lisse, jaune pâle et une mésospore épaisse ponctuée. L'endospore n'a pas été observé. Une fente de déhiscence sigmoïde, très caractéristique était bien visible. Une gelée incolore emplissait le faible espace restant entre la spore et la paroi du sporange.

La figure que nous donnons ressemble beaucoup aux azygospores ou aux zygotes par conjugaison latérale représentés par Iyengar pour *T. indicum*. Mais *T. indicum* possède des plastes présentant 2 séries de pyrénoides et de plus la conjugaison scalariforme y est de règle.

Le trop petit nombre d'observations sur la forme africaine ne nous permet pas de savoir s'il s'agit d'une variété de *T. indicum* ou d'une espèce nouvelle indépendante.

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NEW ENTITIES AND COMBINATIONS IN THE PHAEOPHYCEAE OF NEW ZEALAND

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ABSTRACT

In the course of a revision of the Phaeophyceae of New Zealand, four new species were discovered and are here described: They are *Hecatonema stewartensis*, *Leathesia intermedia*, *Cladosiphon moorei* and *Sargassum johnsonii*. Two more species, previously listed, require description under new names for reasons that are given; they are *Herponema hormosirae* and *Elachista lindaueri*. A species of *Carpophyllum* requires a change of name from *C. elongatum* to *C. angustifolium* as the type material of *C. elongatum* belongs to another species of *Carpophyllum*.

During the course of revising the brown algae of New Zealand a number of new forms and species were encountered. Seven of these are described and discussed in this paper.

The second of these species has been known for some time and has indeed been distributed by V.W. Lindauer in his exsiccatæ under the name of *Elachista australis*. Dr. Papenfuss suggested to me that Lindauer's plant was not identical with the plant described by Agardh as *Elachista australis* and now known as *Philippiella australis* (Ag.) Silva (Silva 1959). This view was confirmed when authentic material of *Philippiella australis* (kindly sent by Dr. Womersley of Adelaide) was examined. The New Zealand plant now requires a description, and I have had great pleasure in naming it after Mr. Lindauer who has been responsible for so much work on the Phaeophyceae in New Zealand.

The fifth of these species, *Sargassum johnsonii*, is of considerable interest, not only on account of its morphology, but also because of its very restricted habitat. In the case of one established species inspection of type material showed that the specific name was not valid. The new species and changes proposed are described below.

1. *Hecatonema stewartensis* sp. nov. (Fig. 1)

Thallo disciformi, $1\frac{1}{2}$ –2 mm. diametro, simplici aut confluentem, cum lamina basali prostrata distromatica facta e filamentis dense adpressis $6\text{--}8\mu$ diametro, subdichotomose ramosis, liberioribus ad peripheriam, cellulis valde variformibus; cellulis in medio disco $1\text{--}2\frac{1}{2}$ -ies longioribus quam latioribus, plerumque $1\frac{1}{4}$ –2-ies; filamentis erectis, 5–8 cellularum, brevibus, omnibus eadem altitudine, cylindricis, ad apicem obtusis, $35\text{--}45\mu$ altis, $6\text{--}10\mu$ latis; villis paucis; membris plurilocu-



Figure 1

Erect filaments and sporangium of *Hecatonema stewartensis*. ($\times 650$)

laribus sessilibus in lamina basali, obovaido-conicis, $35 - 45\mu$ altis, $12 - 18\mu$ latis, $2 - 3$ seriatis cum $6 - 8$ ordinibus loculorum.

Thallus disc-like, $12 - 2$ mm. diam., single or confluent, consisting of a prostrate, distromatic basal layer composed of closely adpressed filaments $6 - 8\mu$ diam., dichotomously branched, becoming free towards the periphery and cells very variable in shape; cells in centre of disc $1 - 2\frac{1}{2}$ times as long as broad, usually $1\frac{1}{2} - 2$ times; erect filaments of $5 - 8$ cells, short, all of equal height, cylindrical, obtuse at apex, $35 - 45\mu$ high and $6 - 10\mu$ broad; hairs occasional; plurilocular organs sessile on basal layer, obovoid-conical, $35 - 45\mu$ high, $12 - 18\mu$ wide, $2 - 3$ seriate with $6 - 8$ tiers of loculi.

Forming small discs or confluent skin-like patches, mostly circular in outline, on the laminae of *Marginariella urvilleana*, *Ecklonia radiata*, *Lessonia* and *Macrocystis*. Type specimen: 10256 Herb. Lindauer in Auckland Univ. Bot. Mus.

Type locality: Chris's Bay, Pegasus, Stewart Island.

Found on *Marginariella*, *Lessonia* and *Macrocystis*. Occurs also on *Ecklonia* at Russell.

2. *Elachista lindaueri* sp. nov. (Fig. 2).

LINDAUER (1939, Fasc. II, No. 29, Isotypes; 1947, p. 552; 1957, p. 64 as *Elachista australis*.

Globulis parvis, lubricis, capillatis, fulvis, subhemisphericis, epiphyticis ad 4 mm. dia.; exteriore regione medullari consistente e filis dichotome ramosis, cellulis oblongis $3 - 4$ -ies longioribus quam latioribus; medulla interiore filamentorum incolorum dichotome ramosorum, ad basim plantae convergentium, cellulis elongatis, cylindricis; assimilatoribus clavatis, sensim curvatis, subter attenuatis, consistentibus e cellulis $2 - 3$ -ies longioribus quam latioribus subter, $6,5 - 7,7\mu$ dia., deinde brevioribus et latioribus, $11 - 12,5\mu$ dia. super, piriformibus; capillis assimilatoriis longis, non ramosis ultra partem assimilatoriam, cellulis $11 - 14,5\mu$ dia., $13 - 20\mu$ longis cum crassis parietibus longitudinalibus; sporangiis unilocularibus obovatis ad rotunda, sessilibus, lateraliter gestis in basi assimilatorum, $30 - 50\mu \times 70 - 110\mu$ dum matura sunt; gametangiis plurilocularibus formatis per commutationem terminorum assimilatoriorum.

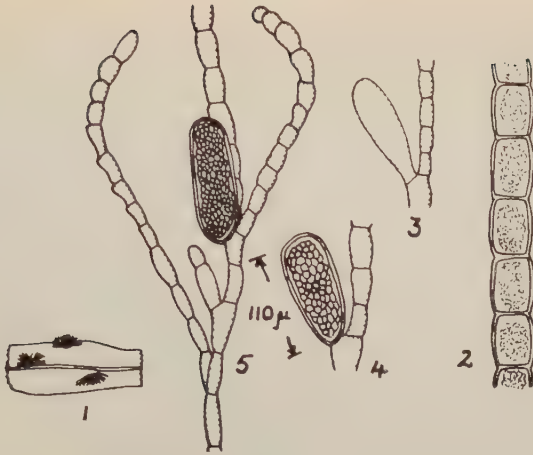


Figure 2

Elachista lindaueri. 1. plants on *Xiphophora* ($\times 2$); 2. part of an assimilatory hair ($\times 700$); 3, 4. young and old unilocular sporangia. 5. unilocular sporangium and assimilators (3–5, same scale).

Small, lubricous, hairy, yellowish-brown, sub-hemispherical epiphytic balls up to 4 mm. dia., outer medullary region consisting of threads dichotomously branched, cells oblong, 2–3 times longer than broad; inner medulla of colourless filaments dichotomously branched, converging towards the base of the plant, cells elongate, cylindrical; assimilators clavate, slightly curved, attenuate below, consisting of cells 2–3 times longer than broad below, $6.5 - 7.7 \mu$ dia., becoming shorter and broader $11 - 12.5 \mu$ dia. above and pear-shaped; assimilatory hairs long, unbranched beyond the assimilatory zone, cells $11 - 14.5 \mu$ dia. $\times 13 - 20 \mu$ long with thick longitudinal walls; unilocular sporangia obovate to round, sessile, borne laterally at base of assimilators, $30 - 50 \mu \times 70 - 110 \mu$ when mature; plurilocular gametangia formed by modification of ends of assimilators.

Epiphytic on *Xiphophora chondrophylla* var. *minus* and var. *maximus*.

Type specimen: No. 29, Herb. Lindauer in Auck. Univ. Bot. Dept.

Type locality: Bay of Islands.

Local distribution: Bay of Islands and northwards where the host plant occurs, Te Kaha, Waihi, Wellington, Dunedin, Stewart Is., Little Barrier. Endemic.

3. *Cladosiphon moorei* sp. nov. (Fig. 3; plate 1).

Plantis per discum adfixis, ad 8 cm longis, lubricis, valde ramosis, flexuosis, diametro plus minusve aequis, obsessis ramulis raris patentibus, subobtusis, ad basim attenuatis, lateraliter emergentibus; axe et ramis primariis transversim tubiformibus, consistentibus ex ordinibus ordinum cellularum subparallelorum simplicium laxe adhaerentium, $16 - 22 \mu$ dia., 5–6-ies longioribus quam latioribus; ordine extremo consistente e cellulis magnis, saepe furcate ramosis, gerentibus cellulas minores ovoides quae efficiunt assimilatores et sporangia unilocularia; assimilatoribus simplicibus, consistentibus e 9–11 cellulis, $6.5 - 10 \mu$ latis, cellulis

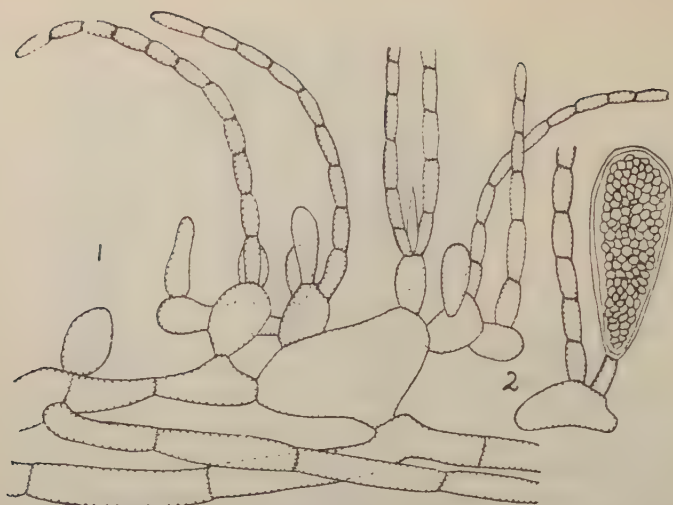


Figure 3

Cladosiphon moorei. 1. assimilators and young unilocular sporangia ($\times 500$); 2. unilocular sporangium ($\times 700$).

inferioribus cylindricis 3–4-ies longioribus quam latoribus, inferioribus cylindricis 3–4-ies longioribus quam latoribus, cellulis superioribus brevioribus, 3-ies longioribus quam latoribus, vix constrictis ad dissepimenta sporangiis unilocularibus piriformibus, $77-92\mu$ longis, $22-33\mu$ latis ad apicem, gestis in stirpe unicellulari aut sessilibus; sporangia plurilocularia non visa.

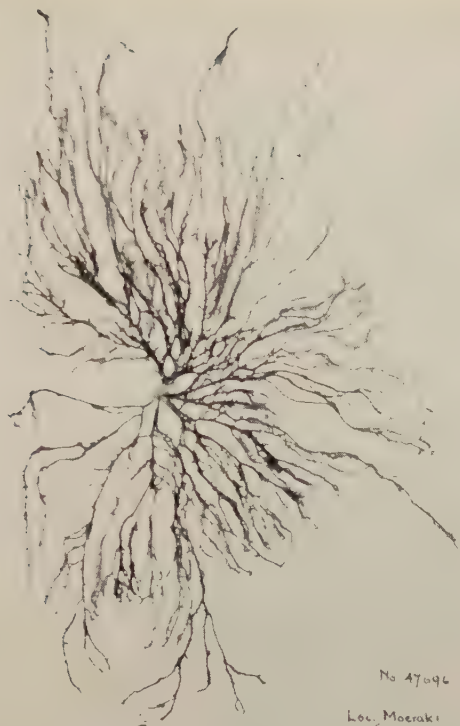
Plants attached by a disc, up to 8 cms. long, lubricous, much branched, flexuous, more or less uniform in diameter, beset with occasional patent, sub-obtuse branchlets, attenuate at base, emerging laterally; axis and main branches tubular in section consisting of rows of sub-parallel, simple and loosely adherent cell rows, $16-22\mu$ dia., 5–6 times longer than broad; outermost layer consisting of large cells, often furcately branched, bearing smaller ovoid cells that give rise to the assimilators and unilocular sporangia; assimilators simple, consisting of 9–11 cells, $6.5-10\mu$ wide, lower cells cylindrical 3–4 times as long as broad, upper cells shorter, 2–3 times as long as broad, scarcely constricted at the dissepiments; unilocular sporangia pear-shaped, $77-92\mu$ long by $22-33\mu$ wide near apex, borne on a one-celled stalk or sessile; plurilocular sporangia not seen.

This species differs from the other New Zealand species of *Cladosiphon* in the shorter assimilators without any terminal moniliform cells, the less compact axial zone and the pear-shaped (as distinct from clavato-obovate) unilocular sporangia. I have much pleasure in naming this after Miss L.B. Moore who found the plant, and who has also contributed so much to New Zealand phycology.

Type specimen: No. 47696. Herb. Bot. Div., D.S.I.R. New Zealand.

Type locality: Moeraki.

Local distribution: Moeraki. Endemic.



No 47696
Loc. Moeraki
Coll. L. B. Moore 1/12/44

HERBARIUM OF	
AUCKLAND UNIVERSITY COLLEGE	
NAME	CLADOSIPHON MOOREI p. 71
FAMILY	Chordanaceae T. L.
LOCALITY	Moeraki
HABITAT, ETC.	
COLL.	L. B. Moore
DET.	V. J. Chapman

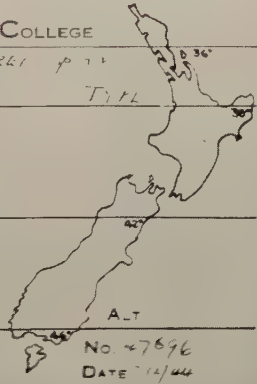


Plate 1
Type specimen of *Cladosiphon moorei* (× 3)

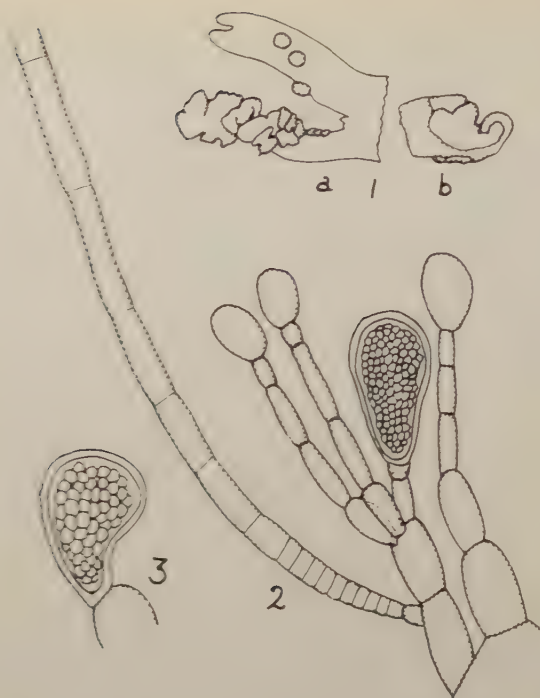


Figure 4

Leathesia intermedia. 1. plant on host (a: 1; b: 3); 2. unilocular sporangium, assimilators and hair ($\times 600$); 3. unilocular sporangium ($\times 600$).

4. *Leathesia intermedia* sp. nov. (Fig. 4).

Thallo epiphytico fulvo-oleagino, carni-gelatinoso, primum hemispherico solido, deinde irregulariter aurito, plus minusve cavo, ad 12 mm diametro, 8 mm alto, simplici aut gregario: medulla magnarum cellularum, laxe congestarum, anastomosentium, ad peripheriam minorum et propius inter se positarum; filamentis assimilatoriis clavatis, consistentibus e 3-6 cellulis, plerumque 4-5, inferioribus $5.5-9\mu$ latis, $1\frac{1}{2}-3\frac{1}{2}$ -ies longioribus quam latoribus, superioribus brevioribus sed non moniliformibus; cellulis terminalibus obovoidibus $25-33\mu$ longis, $22-25\mu$ latis; villis phaeophyceanis longis super thallum sparsis, 12μ diametro; sporangiis unilocularibus ad basim filamentorum assimilatoriorum gestis, piriformibus, $50-60\mu$ longis, $35-37\mu$ latis cum matura sunt.

Thallus epiphytic, olive-brown, fleshy-gelatinous, originally hemispherical and solid, later irregularly lobed, more or less hollow, up to 12 mm. dia. and 8mm. high, single or gregarious; medulla of large, loosely packed, anastomosing cells becoming smaller and closer to each other towards the periphery; assimilatory filaments clavate, consisting of 3-6 cells, usually 4-5, the lower ones $5.5-9\mu$ wide, $1\frac{1}{2}-3\frac{1}{2}$ times as long as broad, the upper shorter but not moniliform, the terminal

cells obovoid, 25–33 μ long by 22–25 μ wide; long phaeophyceean hairs scattered over thallus, 12 μ dia.; unilocular sporangia borne at base of assimilatory filaments, pear-shaped, 50–60 μ long by 35–37 μ wide when mature.

Epiphytic on *Pterocladia*, *Glossophora*, *Ceramium*. Midsummer.

This species differs from *Lcathesia novae-zelandiae* in its larger size when mature, in the shorter assimilators with more swollen terminal cells, and also in the smaller sporangia. In many respects it is intermediate between *L. novae-zelandiae* and *L. difformis*.

Type specimen: In herb. Lindauer, Bot. Dept., Auckland Univ.

Type locality: Stewart Island.

Local distribution: Taranaki (on *Pterocladia*), Stewart Island on *Glossophora* and *Ceramium*. Endemic.

5. *Sargassum johnsonii* sp. nov. (Plates 3).

Planta surgente ab haustorio discoidi, (0–85 cm. longa, fusca, in nigram et fragilem (dumtaxat in stirpe) versa ubi siccata est; axe adulto praelongo, tereti, spiraliter contorto, ramis prope axem ito decidentibus ut nullae marcant cicatrices conspicuae, ad apicem efficiente ramos alternis dispositos ad 12 cm. longos; axibus secundariis pinnate divis, primum subter cicatricosis, deinde aequioribus et contortis, terminatis si immaturi sunt in segmenta frondiformia pinnato-dichotomose divisa ad 3 cm. longa, 2.5 mm. lata, distincte costata; ramulis superioribus et vetustioribus, simplicibus vel cum paucis ramusculis, ferentibus lacinias alternis dispositas, simplices vel dichotomose divisas, 6–10 mm. longas, 1–1.5 mm. latas, sine cryptostomatis; vesiculis non visis; receptaculis gestis in ramulis superioribus, simplicibus, 2–3 mm. longis, lanceolatis, terulosis.

Plant 60–85 cm. long, arising from a discoid holdfast, dark brown, going black and brittle (stem only) on drying; adult axis very long, terete, spirally twisted, branches falling off close to axis so that no prominent scars remain, giving rise near the apex to alternately arranged branches up to 12 cm. long; branch axes pinnately divided, scarred below at first, later becoming smoothed and twisted in appearance, terminating when young in pinnate-dichotomously divided leaf-like segments, up to 3 cm. long and 2.5 mm. wide, distinctly costate; upper and older ramuli simple or with few branchlets, bearing alternately arranged laciniae, simple or dichotomously divided, 6–10 mm. long, 1–1.5 mm. wide, without cryptostomata; vesicles not seen; receptacles borne on upper ramuli, simple 2–3 mm. long, lanceolate, torulose.

This species is extremely outstanding and cannot be confused with any other New Zealand species of *Sargassum*. One reason for this is that it is the only local plant belonging to the section *Cladomorphae* in the genus. It would seem to have its closest affinities with *S. decipiens* (*S. muriculatum*) of Australia and Tasmania. It differs from this species in the very long, torulose main axis and the broader, terminal leaf-like portions. The plant is named after Major M. Johnson who discovered it and has brought back material on more than one occasion.

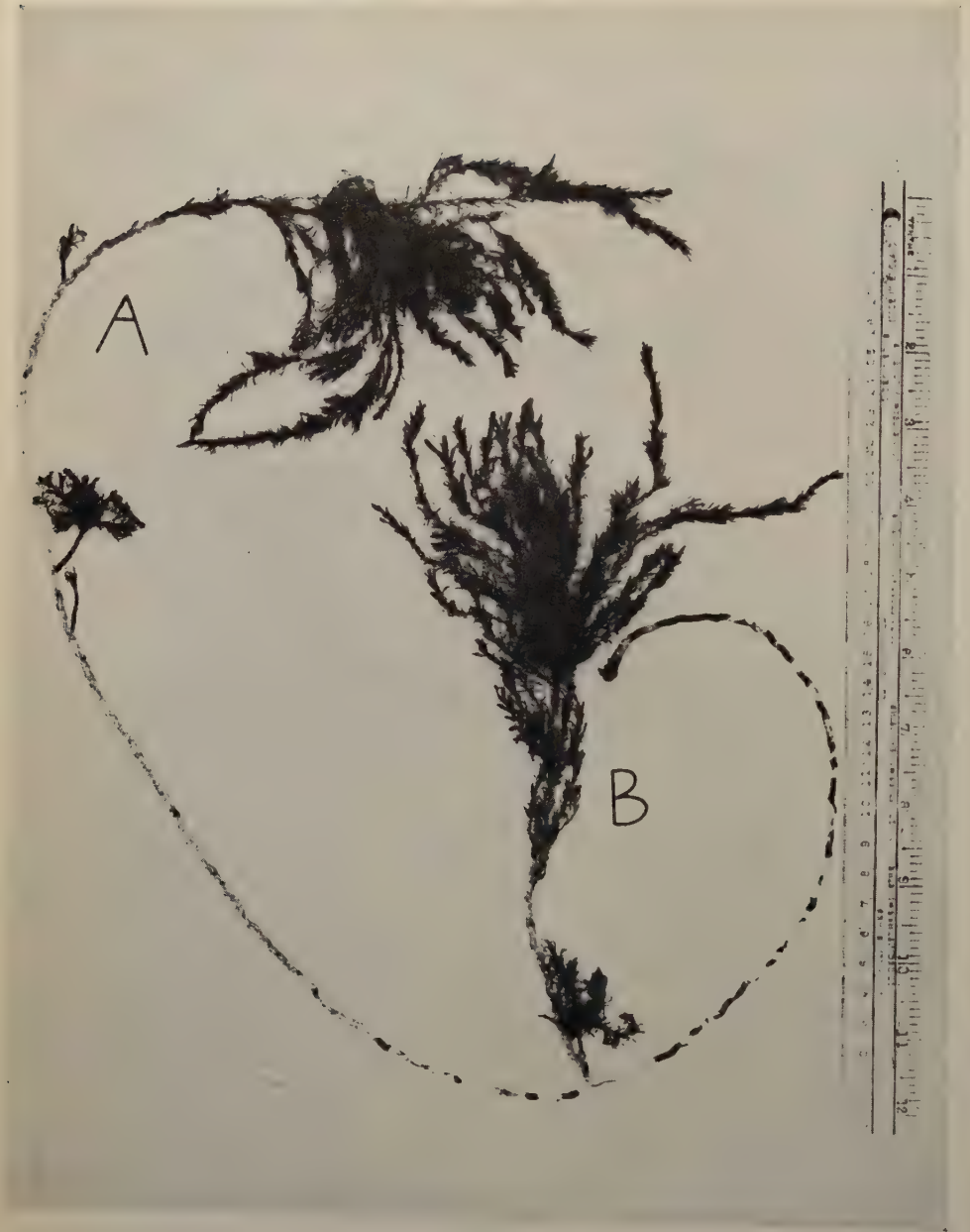


Plate 2

Type specimen of *Sargassum johnsonii*. A = sterile plant; B = fertile plant.

The species is found on the side of a large cave in the Three Kings Island growing below low water mark. Efforts to find it in the extreme northern region of New Zealand only some 30 miles distant have so far failed.

Type specimen: No. 13438, In herb. Lindauer, Bot. Dept., Auckland University.

Type locality: Three Kings Island. Endemic.

6. *Carpophyllum angustifolium* J. Ag. (1877).

This plant has for many years been known as *C. elongatum* (Laing, 1926; Cranwell and Moore, 1938; Lindauer, 1947; Delf, 1939; Naylor, 1954). This name was based upon floating material collected by Moseley 30 miles off the Kermadec Is., and described by Dickie (1876). Dickie's type specimen in the Kew herbarium (Plate 5) is quite clearly a plant of *Carpophyllum maschalocarpum*. A further fragmentary Dickie specimen in the British Museum is also a poor specimen of *C. maschalocarpum*, and indeed from Dickie's statement that his plant has a broader and more compressed stem than *Cystophora platylobium*, one cannot see how it could refer to *C. angustifolium* which characteristically has a narrow stem. When compared with Agardh's plant (Plate 4) the differences between the two species are obvious. A. and E.S. Gepp (1911) compared the Kew plant with Laing's figure (1899) and say that it is like it (*C. elongatum*). They do say that they did not see Agardh's type of *C. angustifolium*. Laing's (1899) description fits the species but the plant he figures (p1. V, fig.1) is not really typical of the species and may be a hybrid. It seems too, that Laing (1899) included this species as a form of *C. maschalocarpum*, as evidenced

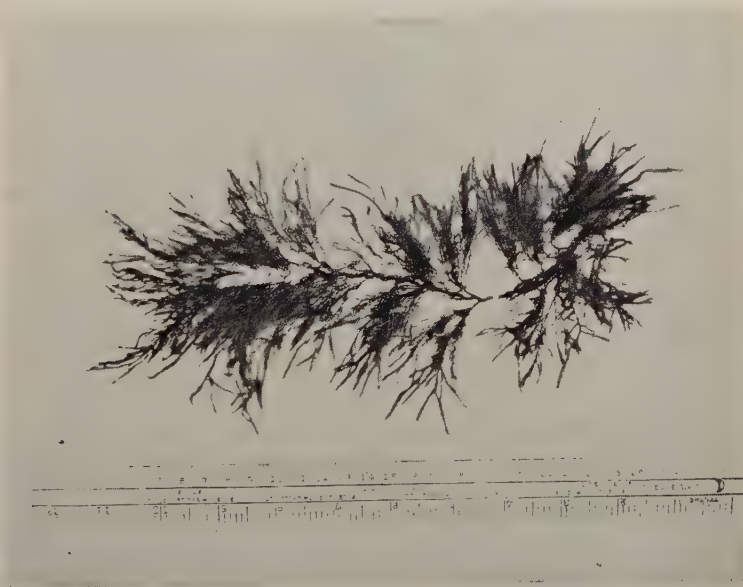


Plate 3
Sargassum johnsonii: young plant.



Plate 4

Agardh's specimen of *Carpophyllum angustifolium* (Photo — Lund Herb.)

by pl. VI, fig. 2 and pl. VII fig. C where it is labelled var. *laxum*. From specimens in Lindauer's herbarium one may suggest that Laing's plant was a hybrid, with *elongatum* 'leaves' and *maschalocarpum* axis.

7. *Herponema hormosirae* Lindauer et Chapman sp. nov.

Lindauer (1947, 76, p.545; 1949, p. 344) as *Sphacelaria pulvinata*;
1953, XIV, No. 334; 1957, p. 62) as *Herponema pulvinatum* (*Ectocarpus pulvinatus* Harv. M.S.) non J. Ag. (see p. 27).



Plate 5

Dickie's specimen of *Cystophora elongatum* (Photo—Kew Herb.)

Thallis gregariis, olivicoloribus dum recentes, fusco-ochricoloribus dum siccati sunt, filamentosis, monosiphonis, articulatis, laxe sparse ramosis, formantibus densas molles spongiosas ad 5mm. altas quae cingunt internodos tumidos *Hormosirae banksii*, plantis consistentibus e filamentis erectis orientibus e male crescentibus basalibus filamentis repentibus; filamentis prostratis fusco-olivicoloribus tortuosis, clavatis, fertilibus, tenuiter furcatis, cum brevibus articulis, cellulis $16-19\mu$ latis; filamentis arcuatis intertextas, $20-30\mu$ latis, totis aequae latis, cellulis $1.5-5$ dia. longis, longioribus in filamentis non ramosis vegetativis, apice obtuso, subapicaliter

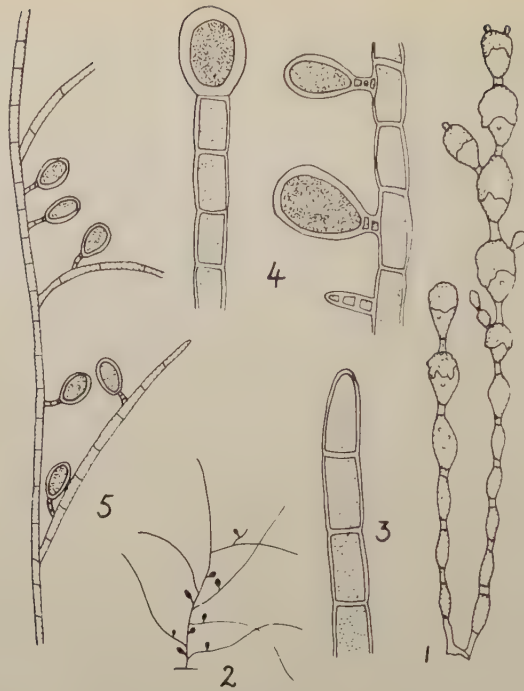


Figure 5

Herponema hormosirae. 1. plant on host ($\times 1$); 2. habit of plant ($\times 7$); 3. tip of filament ($\times 150$); 4. terminal and lateral unilocular sporangia ($\times 150$); 5. portion of erect plant ($\times 30$).

diffuse crescentibus; cytoplasmate opaco olivicolore; nullis capillis; ramis filamentorum fertilium sparsis, plerumque longis, paulo artioribus, $16-20\mu$ latis, plerisque unilateralibus, obtuse transversis, aliis ad basim emergentibus, pluribus ad medium filamentum; sporangiis unilocularibus ovoidibus, sparsis, $80-86\mu$ (-99μ) altis, $56-66\mu$ latis in 1-3 cellulatis pedicellis, plerisque unilateralibus, saepe in seriebus in axe aut singulis in parte superiore rami prope locum insertionis, saepe singula ad basim axis, raro terminalibus in filamentis longis.

Thalli gregarious, olive when fresh, dull ochre when dried, filamentous, monosiphonous, articulated; laxly, sparsely branched, forming densely-entangled, spongy mats up to 5mm. high, surrounding the swollen internodes of *Hormosira banksii*; plants consisting of erect filaments arising from poorly developed basal, creeping filaments; prostrate filaments dark olive, tortuous, knobbly, fertile, slightly forked, with short articulations, cells $16-19\mu$ wide; erect system of branched or unbranched vegetative filaments; filaments arched and entangled, $20-30\mu$ wide, of even width throughout, cells 1.5-5 diameters in length, in unbranched vegetative filaments longer, apex obtuse, growth subapical and diffuse; cells with opaque, olive cytoplasm; hairs wanting; branches of fertile filaments sparse, usually long, slightly narrower, $16-20\mu$ wide, mostly unilateral, at wide angles, some emerging near

base, but usually towards middle of filament; unilocular sporangia ovoid, sparse, $80\text{--}86\mu$ ($\text{--}99\mu$) high, $56\text{--}66\mu$ wide, on 1–3-celled pedicels, mostly unilateral, often in series or single on upper side of branch near its point of insertion, frequently a single one at base of axis, rarely terminal on long filaments.

This epiphyte appears to spread from the narrow node of its host and then extend downwards or upwards, sometimes completely covering the grape-like internodes above or below. In this respect it closely resembles *Myrionema compactum* but, being soft and spongy instead of skin-like, is easily distinguishable.

In a previous contribution (Lindauer, 1949) an attempt was made to show that the alga designated by J. Agardh as *Herponema pulvinatum* (J. Ag., 1872) was actually a *Sphacelaria* and that, unknown to Agardh, it had already been published by Harvey (1855) as such*.

Harvey, however, had died some years before the publication of Agardh's paper, and the discrepancy mentioned above seems to have passed unnoticed. Harvey's original plant, *Ectocarpus pulvinatus* (not that of unknown source from Harvey and used by Agardh in his description of *Herponema pulvinatum*) became entirely overlooked, and naturally its description has never been published. This omission has been remedied now but to avoid further confusion a new specific name has been selected for the present species.

Towards the middle of last century, the chief collections of New Zealand algae with which Harvey had to deal were those of Lyall and Colenso: Lyall's from the South Island, and Colenso's from the North Island. Lyall seems to have had no interest in collecting the numerous conspicuous brown epiphytes of the south, and it is doubtful whether he would have made an exception in this case, although a var. of the plant is to be found there. On the other hand, Colenso was the type of patient and conscientious collector who would miss nothing. As some proof of this, it was Colenso who sent Harvey the type material of *Sphacelaria pulvinata* which is a most inconspicuous epiphyte, so much so that it has subsequently been lost sight of for many years, although it is reasonably plentiful.

Some years ago Lindauer decided to make a thorough inspection of all the larger Phaeophyceae of the Bay of Islands which might possibly act as host to the unknown plant, starting at Paihia where Colenso had lived for many years as printer to the Mission Station. The nearest suitable rocky beach in this locality is at Waitangi two miles away, and there, growing upon the tips of *Hormosira*, a rather conspicuous, low, brown, furry, pulvinate epiphyte was found somewhat resembling *Herponema maculaeforme* in habit. It is inconceivable that Colenso could have omitted to explore this locality, and it may be assumed that he did, and that he collected this epiphyte and forwarded it to Harvey who gave it the manuscript name of *Ectocarpus pulvinatus*, putting it aside for later study. Since this was a manuscript name the species has not yet been validly published and it is therefore now given the Latin diagnosis.

* For the detailed argument Lindauer (1949) should be consulted.

Distribution: On *Hormosira banksii* growing in a pool at mid-tide at base of basaltic platform below the Residency at Waitangi, Bay of Islands. August. Endemic.

I am grateful to Mr. Lindauer for the extensive comments on no. 7.

This work has been made possible by Mr. Lindauer's gift of his collection to Auckland University and I am also grateful to Miss L.B. Moore for giving me access to the D.S.I.R. Herbarium and to the Council of Canterbury University for the continuing loan of the Laing collection. My especial thanks go to Mr. Crawley of Auckland University for the Latin diagnoses, and to Mr. P. Bergquist for drawing the illustrations.

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OBSERVATIONS SUR L'*ENTEROMORPHA TUBULOSA* KÜTZING

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ABSTRACT

Description is given of the morphology, reproduction and development of *Enteromorpha tubulosa* Kützinger collected at Soulac (Gironde). Its position among the systematically related species is discussed.

RESUME

L'*Enteromorpha tubulosa* Kützinger récolté à Soulac (Gironde) est décrit dans sa morphologie, sa reproduction et son développement; sa place par rapport aux espèces voisines est discutée.

Il convient de dire, en manière d'introduction, que nous ne savons pas très bien ce que représente exactement l'*Enteromorpha tubulosa* de Kützinger. Les anciens auteurs se contentaient de descriptions très courtes et l'identification des espèces qu'ils ont créées se heurte, de ce fait, à des difficultés parfois insurmontables. Même lorsqu'il est possible de se référer à un échantillon d'herbier assuré de représenter le type de l'espèce, les difficultés subsistent dans la mesure où certains caractères essentiels ont pu s'estomper ou même disparaître complètement. En ce qui concerne les espèces d'Entéromorphes il convient aujourd'hui de les décrire plus complètement de façon à les rendre aisément identifiables. En agissant ainsi, néanmoins, il se peut que l'interprétation que l'on donne d'une espèce ancienne comporte une part d'arbitraire. Il est même difficile qu'il en soit autrement. Ces considérations sont particulièrement valables pour l'espèce dont nous allons parler maintenant.

L'*Enteromorpha tubulosa* de Kützinger a eu des fortunes diverses. Le Jolis (1863) la considère comme synonyme de son *Ulva enteromorpha* γ *intestinalis* f. *capillaris*. J. G. Agardh (Till Alg.Syst. 1890) en fait une bonne espèce, à vrai dire peu connue, ajoute-t-il, qu'il place dans sa section des *intestinalis*, entre *E. flexuosa* et *E. prolifera*. Pour G. Hamel (1933) l'*E. tubulosa* de Kützinger doit être assimilée à l'*E. compressa* var. *flexuosa* Wulf, c'est à dire à l'*E. flexuosa* J. Agardh. Dans son étude de l'*E. prolifera*, Bliding (1939) considère que l'*E. tubulosa* Kütz. devrait être rattachée à cette dernière espèce au moins en partie. On voit par ces quelques citations que l'*Enteromorpha tubulosa* est loin d'être envisagée comme une espèce valable par la majorité des algologues et nous n'aurions pas été tenté de reprendre ce nom pour l'espèce que nous allons décrire maintenant si nous n'avions pas admis qu'il exis-

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taut, malgré tout, une bonne part de chance que notre espèce pouvait correspondre à l'*E. tubulosa* de Kützing et de J. Agardh. Une autre raison nous influençait au moment où nous avons parlé pour la première fois de cette espèce, le souci de ne pas créer à la légère une entité spécifique nouvelle.

L'Entéromorphe que nous décrivons sous le nom d'*E. tubulosa* a été rencontrée en 1956 à Soulac (Gironde). A cette époque nous l'avons cataloguée comme l'*E. lingulata* J. Ag. (*E. compressa* var. *lingulata* (J. Agardh) Hauck, in Hamel, Chlorophycées, p.156)

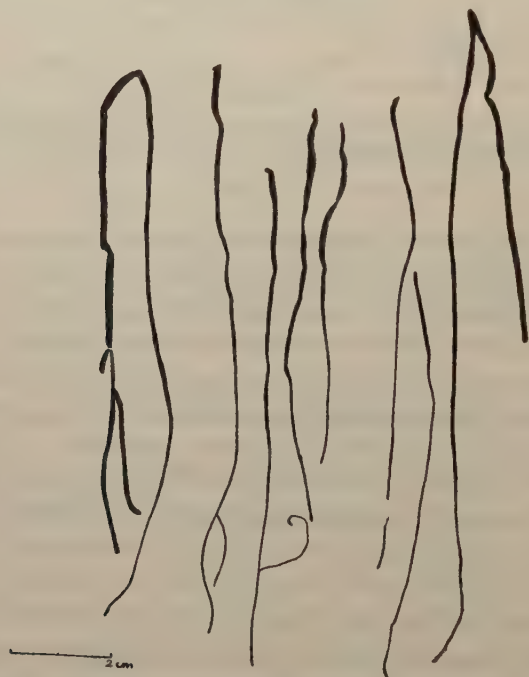


Figure 1

Enteromorpha tubulosa Kützing récolté à Soulac (Gironde)

Depuis cette époque nous retrouvons cette espèce et nous l'observons dans cette station de novembre à juillet (Figure 1). Un peu plus tard, en 1959, nous l'avons retrouvée à Guéthary et sans doute existe elle encore ailleurs, en particulier en Bretagne. Néanmoins, comme pour caractériser cette espèce il est nécessaire de l'étudier très complètement et même, autant que possible, de suivre son dévelop-

pement, nous ne pouvons être sûr, pour l'instant, que des deux stations de Soulac et de Guéthary, et notre description s'inspirera surtout des récoltes faites à Soulac à diverses saisons.

L'E. tubulosa possède un thalle simple ou peu ramifié, linéaire, très longuement atténué et filiforme à la base, tubuleux de bout en bout, atteignant deux décimètres et plus de longueur, ordinairement très étroit et ne dépassant pas un mm dans sa plus grande largeur. Sur les plus grands exemplaires il devient aplati, rubané et d'une largeur pouvant atteindre deux mm. Des ramules existent assez souvent dans la région stipale; ailleurs ils sont généralement rares.

Les cellules, assez alignées parfois, sont plus grandes dans la région stipale et allongées suivant l'axe. Leurs dimensions sont: ($10 \times 15\mu$) environ dans la région moyenne et ($8-10 \times 30-35\mu$) environ dans la région stipale.

Le chromatophore forme une plaque pariétale complexe, réticulée, irrégulière, plus ou moins étoilée, finement perforée, disposée sur la paroi proximale. Il porte un et souvent deux pyrénoides dans la région moyenne du thalle. Dans la région stipale deux, trois et même un plus grand nombre de pyrénoides, sont de règle.

La reproduction a lieu par des zoospores à quatre cils et par des gamètes à deux cils. La copulation entre gamètes se fait ordinairement suivant le mode hétérogame, parfois cependant presque isogame (Planche 1). Les zoospores, légèrement aplaties renferment souvent beaucoup d'amidon et un stigma; les cils dépassent la longueur du corps. Les zoospores ont environ 10μ de longueur sur $4-5\mu$ de largeur.

Le développement à partir des zoospores a été suivi et nous avons donné dans une note récente les caractères des plantules jeunes. Ce développement fait apparaître une formation basale (disque) appliquée sur le support et qui peut acquérir une certaine étendue avant toute formation de filament dressé. Cette production d'un disque rappelle ce qui se passe dans le genre *Blidingia*. Cependant nous n'en tirons pas la conclusion, pour l'instant, qu'il soit nécessaire de rattacher l'*E. tubulosa* au genre *Blidingia*, car, d'après nous, les deux espèces que compte maintenant ce genre (anciennement connues sous les noms d'*E. minima* et d'*E. marginata*) possèdent d'autres points de rapprochement que leur mode de développement, par exemple la petitesse des cellules, le type du chromatophore, les zoospores dépourvues de stigma et de phototactisme. Par conséquent il nous semble prématuré de tirer des conclusions systématiques basées sur le développement pour l'*E. tubulosa*. Néanmoins nous attachons une grande importance, chez les Entéromorphes, aux caractères des premiers stades du développement et nous pensons que ceux de l'*E. tubulosa* sont assez particuliers pour être opposés à ceux d'autres espèces comme l'*E. compressa*.

Pour terminer nous examinerons brièvement quelles sont les espèces voisines de l'*E. tubulosa* et quels sont les caractères distinctifs de celle-ci par rapport à ses congénères. Or l'*E. tubulosa* a certainement des points de ressemblance avec l'*E. gayralii* que nous avons décrit récemment au Maroc, en particulier pour la morphologie, la ramification, les caractères du chromatophore, la région stipale filiforme, l'alignement des cellules. L'*E. tubulosa* diffère spécialement par le caractère tubuleux du

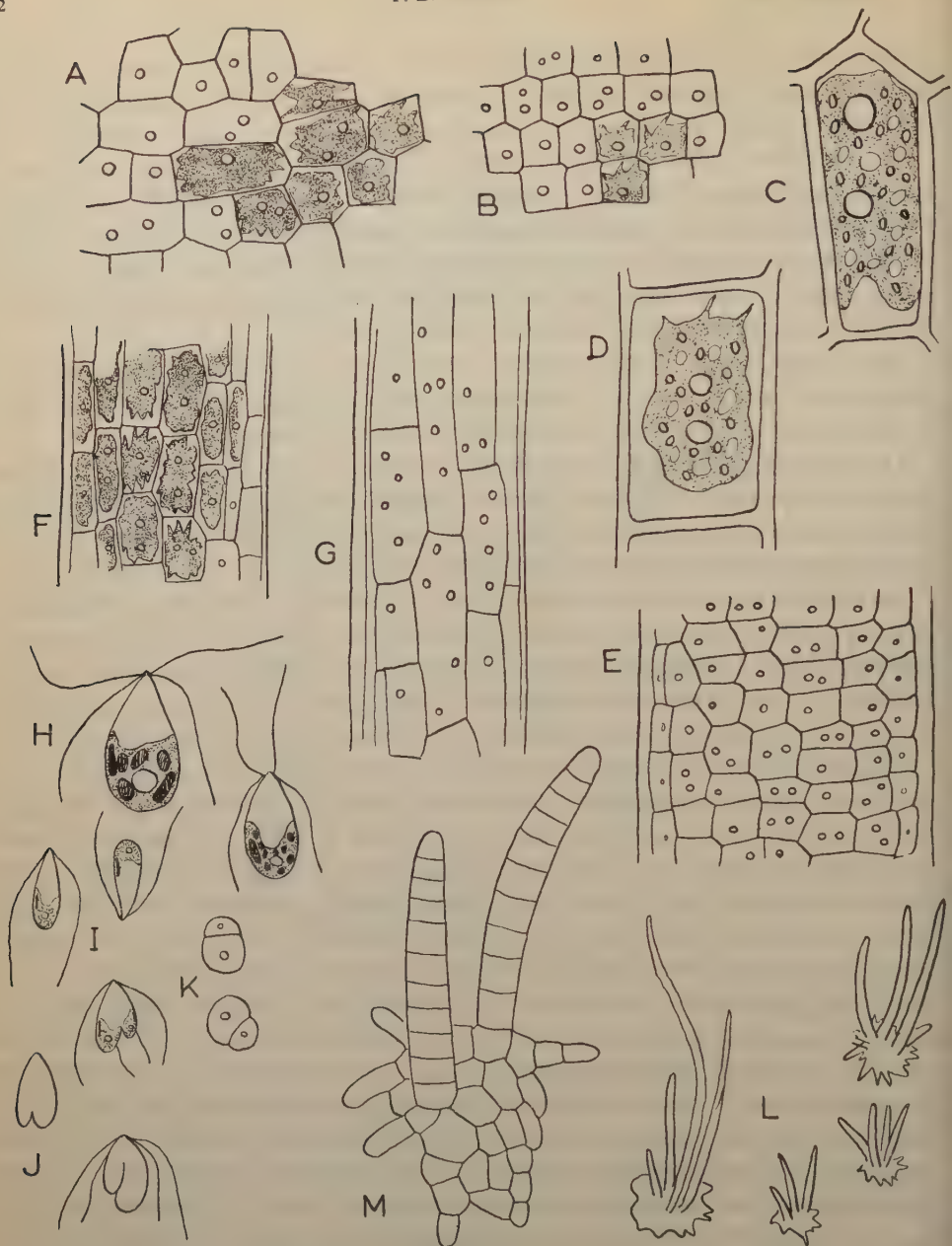


Planche 1

Figure A. Cellules de la région moyenne du thalle; l'alignement est peu net. $\times 500$. Figure B. Cellules de l'axe dans un exemplaire possédant des cellules relativement petites et bien alignées. $\times 500$. Figure C. Cellule prise dans la région stipale: chromophore perforé, grains d'amidon, 2 pyrénodes. $\times 1400$. Figure D. Cellule dans une autre région du thalle, même légende. $\times 1400$. Figure E. Région d'un filament tubuleux, cylindrique. $\times 500$. Figure F. Cellules de la région stipale. $\times 500$. Figure G. Cellules de la région stipale, vers la base: cellules très allongées avec pyrénodes multiples. $\times 500$. Figure H. Zoospores de deux tailles différentes. $\times 1400$. Figure I. Gamètes, $\times 1400$. Figures J-K. Images de copulations hétérogames. $\times 1400$. Figure L. Plantules provenant de zoospores, âgées de trois semaines, montrant le disque bien développé et des filaments dressés multiples. $\times 80$. Figure M. Plantule dans une culture de zoospores, âgée de 15 jours. $\times 500$.

thalle, non rubané en principe; en outre *E. tubulosa* est souvent de grande taille comparé à *E. gayralii*.

D'autre part Bliding a décrit en 1955 une Entéromorphe nouvelle qu'il appelle *E. intermedia*, laquelle rappelle, par certains côtés, l'*E. tubulosa* (nombre de pyrénoides, alignement des cellules), mais qui en diffère par la ramification et surtout, nous le pensons, par le développement. En effet nous avons eu l'occasion de rencontrer des *E. tubulosa* qui étaient exceptionnellement très garnis de rameaux et par conséquent se rapprochaient de l'*E. intermedia* de Bliding. Le développement par contre, semble très différent dans ces deux espèces.

Nous pensons donc, jusqu'à plus ample informé, que notre *E. tubulosa* est une espèce différente de l'*E. intermedia* Bliding, différente également de l'*E. gayralii* P.D. du Maroc.

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A NEW SUBLITTORAL *GRACILARIOPSIS* FROM SOUTHERN CALIFORNIA

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ABSTRACT

Gracilariopsis claviformis is described from sublittoral pebble beds at Santa Cruz Island, California. Characters of male plants show near relationship to *G. robusta* and *G. andersonii*.

Fertile, sexual material, both dry and in liquid preservative, of an undescribed *Gracilariopsis* species was recently submitted for study. Dr. Michael Neushul had collected it during a series of aqua-lung dives in the kelp beds of the Southern California Channel Islands from aboard the M/V Orca from the Scripps Institution of Oceanography. Because of its distinctive form it is given the name *Gracilariopsis claviformis* sp. nov. It is characterized as follows:

Thalli 3.5–4.5 cm. alti, calculis per discum 2.0–3.5 mm latum affixi, 1–aliquo stipitibus cylindricis brevissimis e disco orientibus, vicissim intra 1–2 mm ramosis, efficientibus ramos aggregatos longo-clavatos obtusos rigidos erector, simplices aut interdum semel dichotome ramosos, 3 mm diam. vel plura attingentes; thalli in structura e medulla magna cellularum membranas tenues habentium 300–400 μ diam., atque e cortice tenui cellularum parvarum coloratarum 30 μ diam. vel minorum constantes; tetrasporangia 45–50 μ long., in soro amplo incrassationem parvam circum superficiem superiorem totam ramorum erectorum formante orientia, soro modificationem corticis nemathacialem mediocrem praebente; cystocarpi pauci prominenter tumescentes c. 1300 μ diam., ostiolo paululum rostrato praediti; gonimoblasta matura solida, basim planam, c. 600 μ latam habens; carposporae c. 25 μ diam.; spermatia 3–4 μ diam., angularia, e superficie interiore sacculorum conceptaculorum profundorum 70 μ profunditate, 35 μ diam., per aperturam parvam superficiei aperientium, abunde orientia; conceptacula antheridialia conferta in soris nemathecialibus, extremitates superiores ramorum erectorum occupantibus, inflationem parvam efficientibus.

Thalli 3.5–4.5 cm. high, attached to small pebbles by a disc 2.0–3.5 mm. broad from which 1 or several very short, cylindrical stipes arise which in turn branch within 1–2 mm. and give rise to a group of long-clavate, blunt, rigid, erect, simple



Figure 1

Gracilariopsis claviformis sp. nov. A male plant from the type collection, $\times 1.5$.

or sometimes once dichotomous branches reaching 3 mm. in diameter or more: structure consisting of a large medulla of thin-walled cells $300\text{--}400\mu$ in diameter and a thin cortex of small, pigmented cells 30μ or less in diameter; tetrasporangia $45\text{--}50\mu$ long, borne in an extensive sorus forming a slight swelling around the whole upper surface of erect branches, the sorus showing moderate nemathecial modification of the cortex; cystocarps few, prominently bulging, about 1300μ in diameter, with a slightly rostrate ostiole; mature gonimoblast massive, with a broad, flat base about 600μ broad; carpospores about 25μ in diameter; spermatia $3\text{--}4\mu$ in diameter, angular, abundantly produced from the inner surface of deep conceptacular pockets, 70μ deep, 35μ in diameter, opening to the surface by a small aperture, the antheridial conceptacles closely spaced in nemathical sori occupying the upper ends of the erect branches and causing slight swelling.

Holotype: M. Neushul, Jan. 30, 1957, deposited in the Herbarium of the University of California, Berkeley. An isotype is in the herbarium of the Beaudette Foundation, Solvang, and another in the Allan Hancock Foundation, Los Angeles.

Type Locality: Growing on a pebble bed at a depth of 30 feet near Gull Island, Santa Cruz Island, California.

This distinctive species appears to be most closely related, by manner of its antheridial characters, to *Gracilariopsis robusta* (Setchell) Dawson and *G. andersonii* (Grunow) Dawson, from both of which it is amply distinct in the swollen, club-

like, rarely-branched erect axes. *G. robusta* is several times branched above, but not below. *G. andersonii* has a clumping habit from a semi-stoloniferous base, occupies intertidal localities, and is scarcely or not at all swollen. This adds an eighth species to this genus from the Pacific Coast of North America as monographed by the writer in 1949 (Studies of Northeast Pacific Gracilariaceae, Allan Hancock Found., Occ. Papers, 7: 1-105).

QUELQUES RHODOPHYCEES DORSIVENTRALES ET BILATERALES
DES COTES ISRAELIENNES

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ABSTRACT

Six species of Red Algae, with dorsiventral and bilateral structure, gathered on the Mediterranean and Red Sea shores of Israel are described. They belong to four genera, three of which (*Herposiphonia*, *Lophosiphonia* and *Pterosiphonia*) are of the family Rhodomelaceae and one (*Heterosiphonia*) of the family Dasyaceae. Their description, biology, ecology and geographic distribution are given.

Cette étude traite de quelques algues de petite taille ressemblant à des *Polysiphonia* et caractérisées par leur structure dorsiventrale ou bilatérale; elles appartiennent aux genres *Herposiphonia*, *Lophosiphonia*, *Pterosiphonia* et *Heterosiphonia*. Les trois premiers, d'après Kylin (1956), appartiennent à la famille des Rhodomélacées à cause de leur croissance monopodiale, tandis que l'*Heterosiphonia* fait part des Dasyacées à cause de sa croissance sympodiale.

Aucun travail n'a été publié jusqu'à présent sur les Algues Rouges des côtes méditerranéennes d'Israël: c'est pourquoi nous avons jugé intéressant d'apporter cette petite contribution à leur connaissance.

Pour faciliter l'identification de ces 4 genres nous adaptons la clé suivante, fortement simplifiée.

I. Organisation dorsiventrale du thalle

- a. ramification exogène, apex enroulé *Herposiphonia*
- b. ramification endogène, apex non enroulé *Lophosiphonia*

II. Organisation bilatérale du thalle

- a. axe dépourvu de ramules monosiphonés; toutes les ramifications sont polysiphonées *Pterosiphonia*
- b. axe pourvu de ramules monosiphonés, ramifiés et colorés.. *Heterosiphonia*

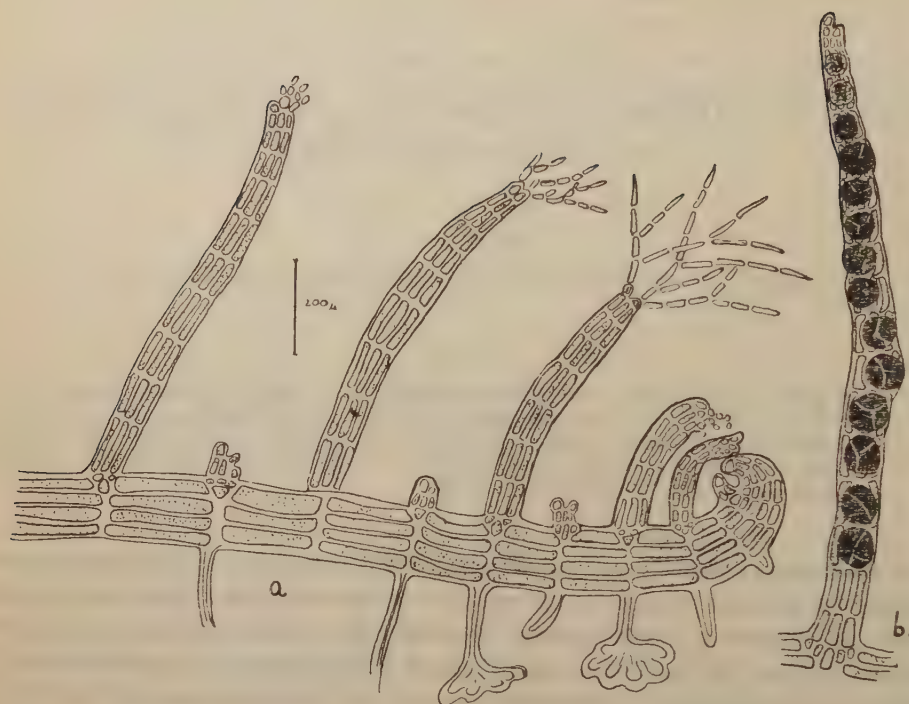


Figure 1

Herposiphonia tenella (rêcocté àchzib). a, Fragment d'un filament rampant avec son apex enroulé;
b, Tétraspores

LE GENRE *Herposiphonia* NAEGELI

Les *Herposiphonia* ne sont pas fréquents le long des côtes d'Israël. Nous y avons trouvé deux espèces: l'*H. tenella* et *H. secunda*, de même qu'un certain nombre de formes intermédiaires.

Les algues se rapportant à ce genre présentent un mode de ramification caractéristique et assez constant qu'on prend aussi en considération pour distinguer les espèces. D'après Falkenberg (1901), les rameaux longs et courts y sont disposés en quatre rangées orthostiches: les deux rangées extérieures, latérales, portent des rameaux alternes à croissance indéfinie — rameaux longs, qui peuvent se développer à leur tour en de nouveaux filaments rampants; les deux intérieures, dorsales, forment des rameaux courts à croissance définie. Chez les individus typiques de chaque

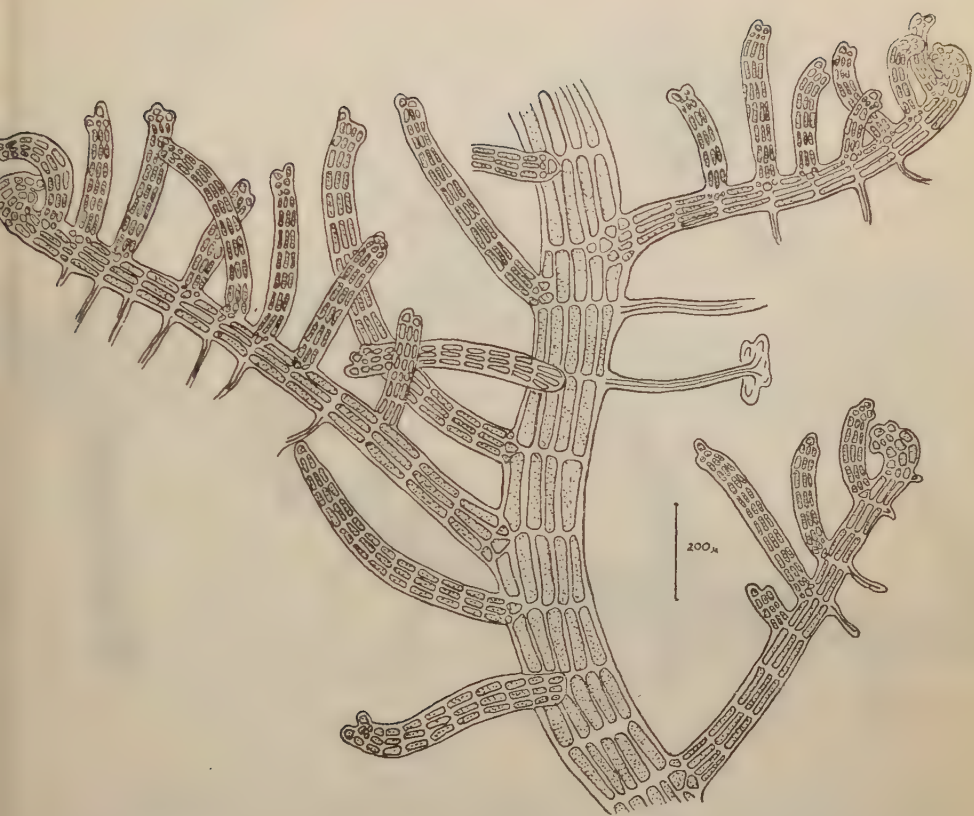


Figure 2

Herposiphonia tenella, forme aberrante (Tantura).

espèce les rameaux longs et courts se succèdent d'après un ordre fixe, mais il y a de nombreuses irrégularités dans cette succession (cf. Boergesen 1915-1920, p.289).

***Herposiphonia tenella* (Ag.) Naeg. (Figures 1, 2, 3, 10a,c)**

Rampe sur les rochers, à l'ombre et forme de petites touffes rouges; se trouve aussi dans des cuvettes par 30-50 cm de profondeur. A Caesarea nous l'avons trouvé associé au *Lophosiphonia obscura* sur les colonnes submergées de l'antique port.

Son thalle est très délicat, d'un rouge-clair qui ne change pas après dessiccation. La ramification est régulière mais ne correspond pas toujours au schéma de Falkenberg (voir plus bas.)

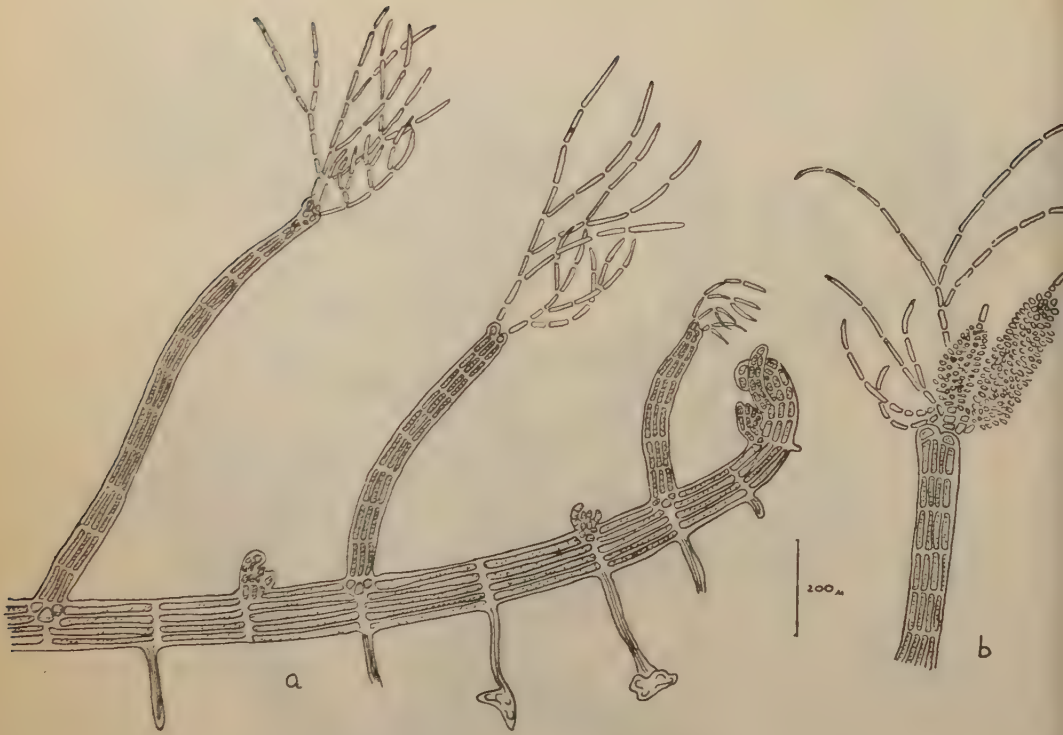


Figure 3

Herposiphonia tenella de la Mer Rouge. a, Filament rampant; b, Extrémité d'un rameau portant des spermatanges

Les rameaux longs stériles se terminent par des trichoblastes ramifiés, hyalins, mais ceux qui portent des tétrasporanges en sont dépourvus. Les rameaux jeunes sont un peu courbés dans la direction de l'apex enroulé en colimaçon. L'axe a dans les exemplaires typiques 60 à 80 μ de diamètre, 5 mm de hauteur et ses segments sont 1—2 fois plus longs que larges; il forme beaucoup de rhizoïdes qui s'élargissent en un disque; les rhizoïdes et les ramifications sortent toujours à l'endroit de la cloison transversale.

La section transversale montre d'une façon typique 6 à 8 cellules péricentrales et pas de cortication. Les tétrasporanges (Figure 1b) ont été trouvés en février dans la Mer Rouge et en juin dans la Méditerranée. Ils sont disposés sur des rameaux longs en une seule rangée: chaque segment porte un seul sporangie divisé en tétra-

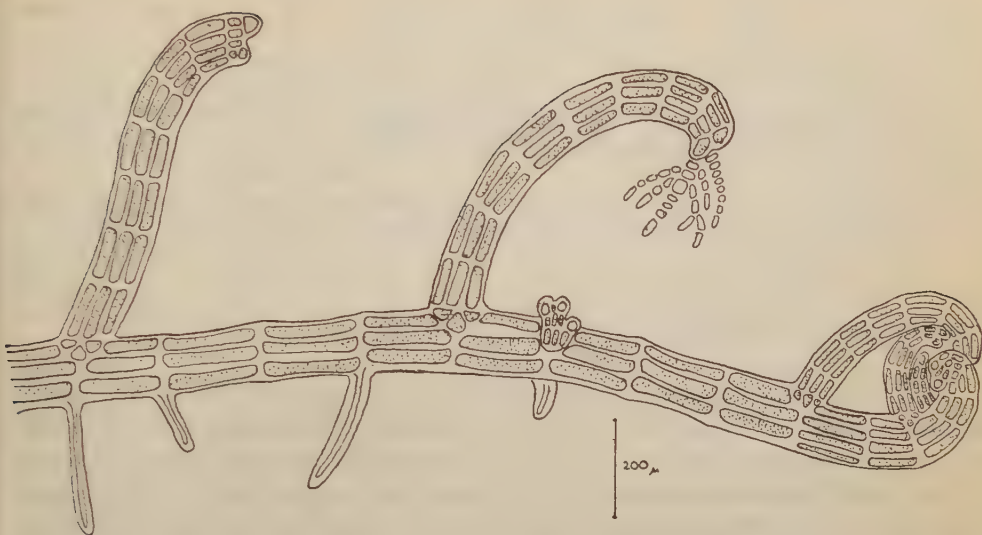


Figure 4

Herposiphonia secunda (Shave-Zion) montrant l'absence des rameaux courts.

ède. Les spermatanges n'ont pas encore été trouvés dans la Méditerranée; nous les avons vus sur nos exemplaires de la Mer Rouge (Figure 3b) et ils ressemblent parfaitement à la figure qu'en donnent Boergesen (1915—1920) et Nasr (1947). Ils sont groupés au sommet des rameaux longs et chacun d'eux se termine par trois à six cellules stériles, ce que d'après Boergesen (1939) est caractéristique pour cette espèce. Nous n'avons pas trouvé de cystocarpes.

Les exemplaires de la Mer Rouge se sont richement développés sur des plaques de verre qui ont été submergées par Prof. Steinitz à Eylath, par la profondeur d'un demi à 1 mètre, dans le but d'étudier la faune et la flore qui s'y fixeraient à des intervalles définis. Après deux mois nous avons trouvé cette espèce adhérant aux couches des Corallinacées qui se sont collées directement au verre dépoli. Les échantillons de la Mer Rouge sont un peu différents de ceux de la Méditerranée: leurs filaments sont plus délicats ($40\text{--}60\mu$ atteignant rarement le diamètre de 80μ); les segments sont plus longs (3 à 5 fois plus longs que larges); les cellules péricentrales sont en nombre de 10—11; les rameaux se succèdent généralement d'une façon suivante: long-court-absent, long-court-absent (Figure 3a) ce qui correspond au schéma de Boergesen pour *H. tenella* des Indes occidentales.

Les trichoblastes sont bien développés et les sporanges, trouvés en février, sont disposés au milieu d'un rameau long vertical en une rangée très longue contenant jusqu'à 16 sporanges.

Loc. Côte méditerranéenne d'Israël: Achzib, 8.II.1958; Tantura, 16.V.1960; Caesarea, 15.VI.1959 (tétrasporanges). Côte israélienne de la Mer Rouge: Eylath, 15.II.1960, avec tétrasporanges et spermatanges.

Distrib. Méditerranée occidentale; Canaries; côtes atlantiques d'Europe et d'Afrique; Indes occidentales; Mer Rouge; Océan Indo-Pacifique; Archipel Malais; Australie; Polynésie.

***Herposiphonia secunda* (Ag.) Naegeli (Figures 4, 5, 10b)**

Vit souvent en épiphyte, près du niveau. C'est une algue plus robuste que la précédente, d'un rouge brunâtre, devenant presque noire par dessiccation. Les filaments rampants sont fixés par plusieurs rhizoïdes très longs qui sortent du côté ventral entre deux segments consécutifs. Du côté dorsal se forment des rameaux dressés, longs et courts, mais les courts sont souvent défectueux (Figures 4, 10b) (voir plus bas le schéma). Les rameaux longs se développent souvent en de nouveaux filaments rampants. Les trichoblastes sont absents. L'axe rampant a 90 à 120 μ de diamètre et ses segments sont seulement deux fois plus longs que larges. La section transversale montre 8 à 10 cellules péricentrales et pas de cortication.

Les tétrasporanges ont été trouvés en avril, juin et juillet; ils se forment sur des rameaux longs, trois à six par rangée; les rameaux qui portent des sporanges ne sont pas renflés.

Nous n'avons trouvé ni des spermatanges ni des cystocarpes.

Loc. Shave Zion, 26.VIII.1953; Bâth Galim près Haïfa, 1.III.1960, et 17.VII.1955 (tétrasporanges); Tantura, 7.VII.1960, épiphytes sur *Laurencia obtusa* et *Spyridia filamentosa* récoltés aussi le 3.IX.1957; Tel-Beruch près Tel-Aviv, 26.VI.1959, épiphyte sur *Ulva* et formant sur la surface verte de cette algue une croûte assez dense d'un rouge-brunâtre; Bath-Yam, 11.IV.1944 (tétrasporanges).

Distrib. Méditerranée occidentale; Canaries; côtes atlantiques d'Europe, d'Afrique et d'Amérique; Indes occidentales; Cap de Bonne Espérance; Océan Indo-Pacifique; Archipel Malais; Australie; Polynésie.

Comme plusieurs exemplaires de notre collection nous paraissaient être des formes intermédiaires, se rapprochant par certains caractères à l'une de ces espèces et par d'autres à l'autre, nous avons choisi un petit nombre de caractères morphologiques simples permettant de distinguer les représentants typiques de l'*Herposiphonia tenella* et d'*H. secunda* et voir clairement les écarts et les tendances de leurs formes aberrantes. Nous avons dressé à cette intention un tableau comparatif suivant:

	<i>Herposiphonia tenella</i> ((typique)	<i>Herposiphonia secunda</i> (typique)
Ramification*	D'après la formule de Falkenberg, les rameaux sortent de chaque cellule de l'axe: lcclc D'après la formule de Boergesen (West Indies): lc. lc. lc.	Les rameaux courts manquent souvent. Ramification d'après Falkenberg: l. . cl. . cl D'après Boergesen: lc...lc...
Diamètre	Jusqu'à 80μ	90–120μ et davantage
Nombre de cellules péricentrales	6–8 d'après Preda; 8–16 d'après Boergesen	D'une façon constante: 8–10
Couleur	Rouge clair ne changeant pas après dessiccation	Rouge-brunâtre, noircissant après dessiccation
Habitat	Rampe généralement sur les rochers	Généralement épiphyte

* En simplifiant le schéma de Falkenberg nous ne prenons pas en considération le côté d'où sortent les rameaux longs et courts. Nous les désignons simplement comme suit: l = rameau long; c = rameau court; . = absent.

A la lumière de ces faits, nous pouvons considérer les exemplaires de *Herposiphonia tenella* de Caesarea et d'Achzib comme aberrants pour leur ramification qui présente de rares interruptions; ceux d'Achzib sont aussi plus épais (70–100μ).

Les exemplaires récoltés à Tantura, le 16.V.1960, (Figure 2) nous ont paru si particuliers que nous les avons envoyés au Prof. J. Feldmann pour lui demander son compétent avis. Ils ont la couleur rouge-clair de *H. tenella*, se trouvent dans des stations semblables, les rameaux secondaires sortent de chaque cellule de l'axe, avec de très rares interruptions**) mais le diamètre est de 120–160μ, les péricentrales sont en nombre de 7 à 11, les trichoblastes sont absents et les ramules secondaires sont toujours disposés d'un seul côté. La cellule apicale a quelquefois l'apparence d'une fourche aux rameaux inégalement développés.

L'éminent Algologue nous a répondu par une lettre détaillée pour laquelle nous tenons à lui exprimer ici-même notre profonde reconnaissance. A la suite d'un

** Sur le fragment de l'échantillon envoyé à Prof. Feldmann, la succession est comme suit:

clccclc...ccccclclclccccccccclcccccl

premier examen il rapporte notre algue à l'*H. tenella* et ne pense pas qu'il soit possible, malgré toutes ses irrégularités, de distinguer cette algue spécifiquement.

Enfin, dans les exemplaires récoltés à Eylath (Mer Rouge) la ramification correspond parfaitement au schéma de Boergesen mais ils ont 10 à 11 cellules péri-centrales.

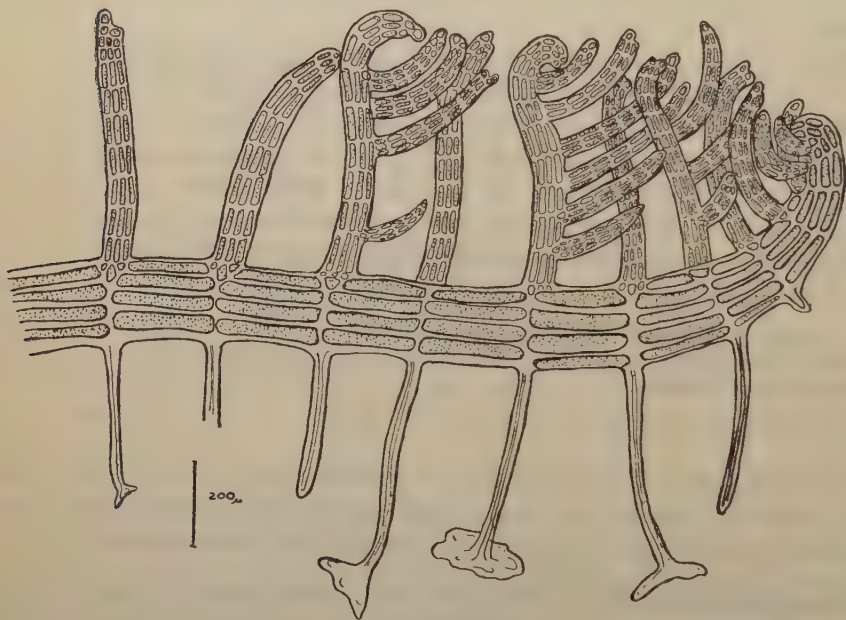


Figure 5

Herposiphonia secunda, forme aberrante (Tel-Baruch).

Quant à l'*H. secunda*, les exemplaires de Tel Baruch (Figure 5) montrent une ramification très dense, chaque segment formant un rameau (lclclclcl). Ces rameaux sont tous de même hauteur, mais les rameaux à croissance indéfinie (r. longs) ont l'apex courbé et portent souvent des ramules secondaires unilatérales, tandis que les rameaux à croissance définie (r. courts) sont toujours droits et simples. L'axe rampant est aussi plus épais: 60 à 198µ.

Les échantillons de Bath-Yam, de Tantura et de Shave-Zion ne forment point de rameaux courts. Leur ramification est: 1.1.1.1. ou: 1..1..1.. ou: 1...1...1... Les exemplaires de Shave-Zion ne noircissent pas par dessiccation.

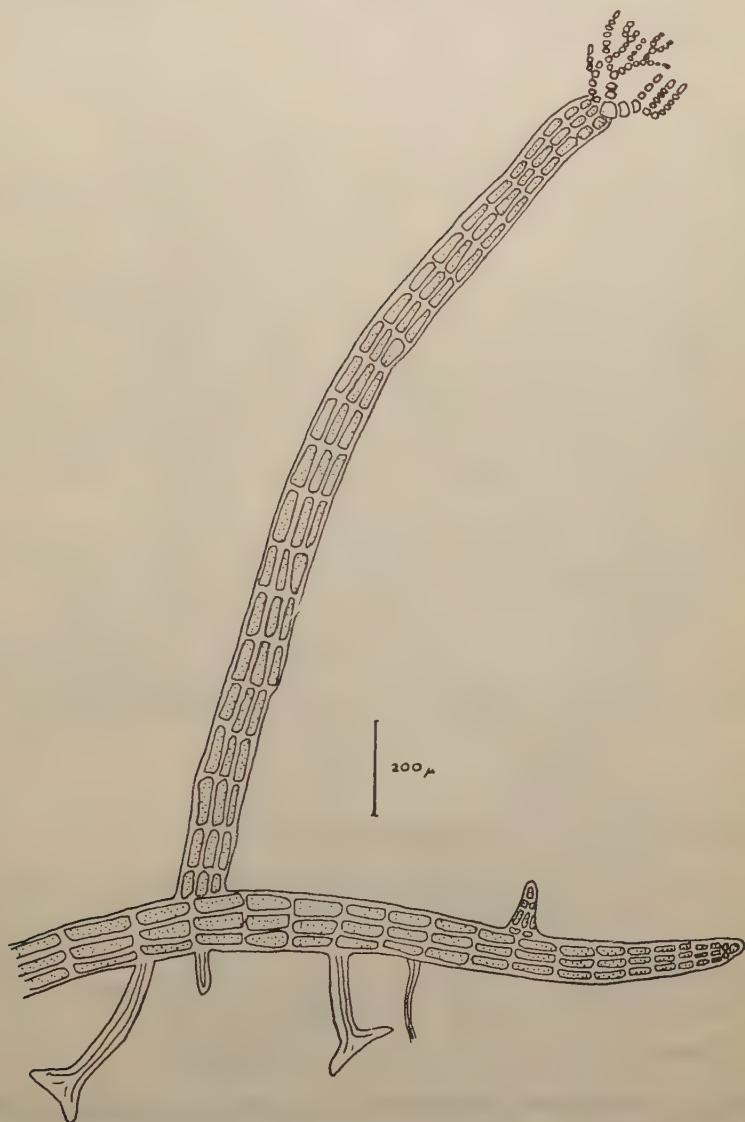


Figure 6

ophosiphonia subadunca, fragment d'un filament rampant avec son apex droit.

LE GENRE *Lophosiphonia* FALKENBERG

L'axe horizontal des algues se rapportant à ce genre rampe en se fixant par des rhizoïdes unicellulaires et forme ses rameaux verticaux d'une façon endogène. Son apex est droit ou peu courbé vers le substratum. Il n'y a pas de différences entre les rameaux courts et longs et tout rameau peut devenir horizontal et rampant.

On trouve deux espèces sur les côtes d'Israël: *L. subadunca*, plutôt rare et *L. obscura*, de beaucoup plus fréquente.

Lophosiphonia subadunca (Kütz.) Falkenberg (Figures 6, 10d)

A été trouvée une seule fois à Acco (Bustan-Ha-Galil) le 27.VIII.1953. Elle forme des touffes rigides, plus ou moins denses, hautes de 1 à 1.5 cm. Ses rameaux adhèrent un peu au papier et sont de couleur rouge-clair, même après dessiccation. Les filaments rampants ont 80 à 100 μ de diam. et se fixent au substratum par des rhizoïdes allongés. Les rameaux dressés sont longs, droits, pour la plupart simples, terminés par des trichoblastes hyalins et sortent à des distances très régulières, de chaque septième segment. Cette ramification est presque constante et donne à notre algue une apparence caractéristique. En section transversale on trouve d'une façon constante six cellules péricentrales, ce que, d'après Boergesen (1939) est caractéristique pour cette espèce.

Notre échantillon est stérile; il correspond à la f. *intricata* (J.Ag.) De Toni (Hauck 1885, p.235; Preda 1908, p.199).

Loc. Acco (Bustan-Ha-Galil), 27.VIII.1953.

Distrib. Méditerranée occidentale; côtes atlantiques de France; Golfe d'Iran.

Lophosiphonia obscura (Ag.) Falkenberg (Figures 7, 10e)

Cette espèce est assez fréquente sur les côtes israéliennes et vit sur des rochers battus de la première zone littorale ou dans des cuvettes. Elle peut aussi ramper comme épiphyte sur différentes algues (*Hydroclathrus clathratus*, *Ulva*). Elle forme des touffes hautes de 1 à 3 cm associées souvent à celles de *Sphacelaria*, *Gelidium*, *Jania*, *Polysiphonia*. Sa couleur est pourpre foncé, quelque peu brunâtre, noircit fortement après dessiccation. Elle n'adhère pas au papier.

Les filaments sont rigides, enchevêtrés et ramifiés richement d'une façon très irrégulière. L'axe rampant se fixe au substratum par des rhizoïdes unicellulaires formés d'un long pied et d'un disque d'adhésion. Son apex est droit et ses segments sont presque carrés.

Plusieurs rameaux secondaires sortent du côté dorsal ou latéral de l'axe et la distance entre eux n'est pas constante. Ils sont aussi de longueur différente: les uns restent courts et simples, les autres s'allongent et forment de nouvelles ramifications secondaires qui peuvent à leur tour donner naissance à de petits ramules courbés vers l'axe principal. Les rameaux secondaires peuvent être verticaux ou

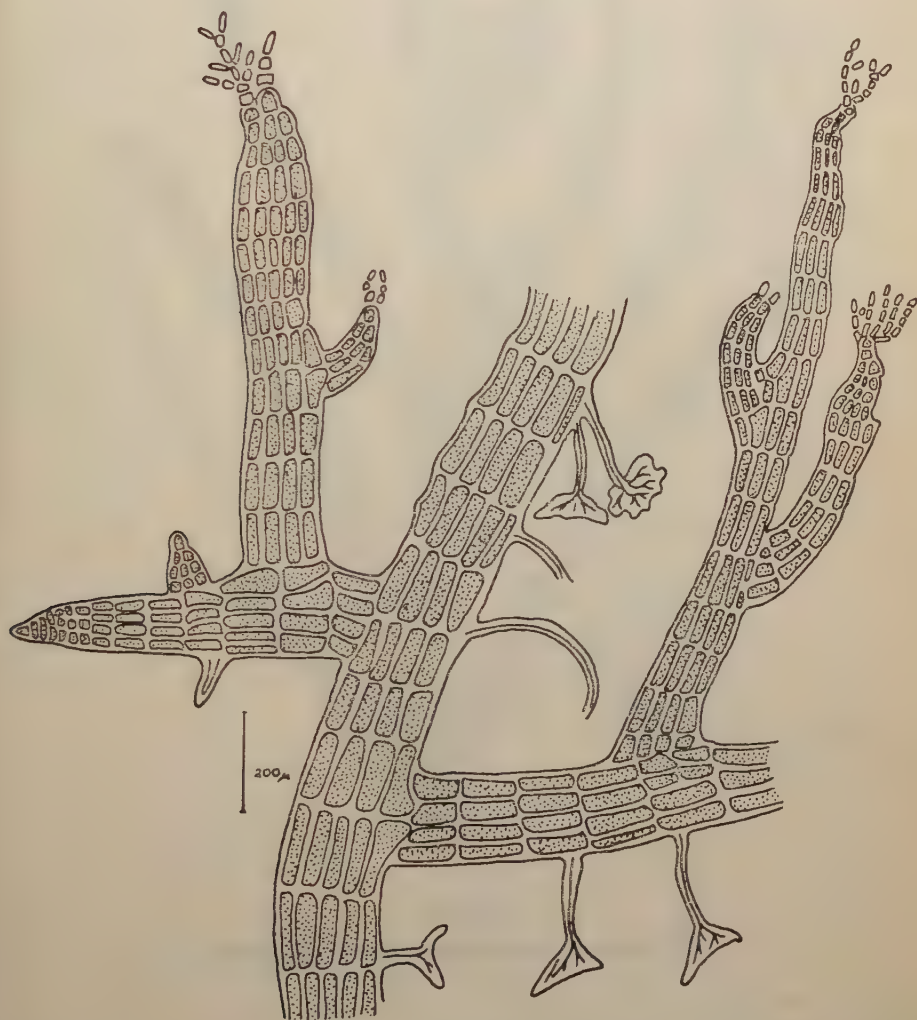


Figure 7

Lophosiphonia obscura, ramification irrégulière caractérisant cette espèce.

horizontaux; les verticaux portent à leur sommet des trichoblastes qui se ramifient régulièrement par dichotomie et qui tombent facilement.

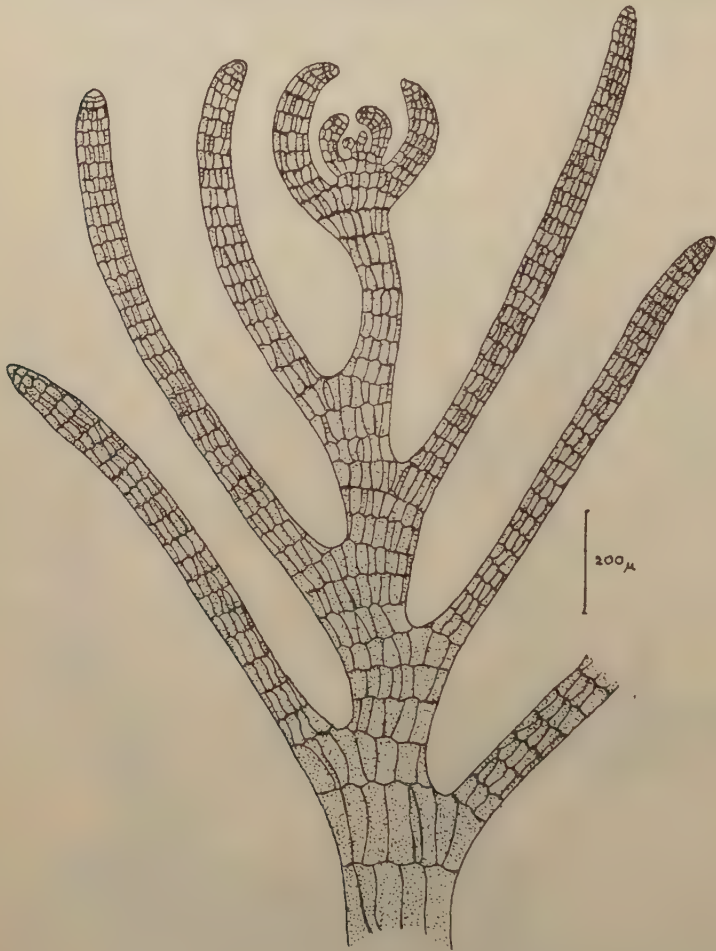


Figure 8

Pterosiphonia pennata, extrémité d'un rameau dressé.

Le diamètre de l'axe mesure 110–120 μ . Preda (1908) indique pour cette espèce 60–90 μ de diamètre, mais dans les collections du British Museum les échantillons récoltés dans la Méditerranée (à Cettes) ont souvent le même diamètre que les nôtres. En section transversale on voit 10–18 cellules péricentrales.

Nous avons récolté cette espèce plusieurs fois en Janvier, Mai, Juin et Août— toujours stérile.

Loc. Haïfa, 27.VIII.1953; Tantura, 16.V.1960; C  sarea, 15.VI.1959; Tel Baruch, 26. VI.1959; Bath Yam, 24.I.1960.

Distrib. M  diterran  e; c  tes atlantiques d'Europe et d'Am  rique; Indes occidentales; Archipel Malais; Japon; Australie; Polyn  sie.



Figure 9

Heterosiphonia wurdemanni, fragment d'un filament ramifi  .

LE GENRE *Pterosiphonia* Falkenberg

L'axe principal rampe au d  but sur le substratum et s'y attache par des rhizo  ides unicellulaires; ses parties jeunes se dressent librement et forment des rameaux alternes polysiphon  s, d  pourvus de trichoblastes. La ramification est distiche.

Les espèces de *Pterosiphonia* sont de petites algues qui habitent particulièrement les mers chaudes. Nous avons trouvé chez nous une seule espèce.



Figure 10

Dessin schématique montrant la ramification des espèces étudiées dans le texte. a, *Herposiphonia tenella* b, *Herposiphonia secunda* c, *Herposiphonia tenella* forme aberrante; d, *Lophosiphonia subadunca* e, *Lophosiphonia obscura* f, *Pterosiphonia pennata* g, *Heterosiphonia wurdemanni*.

***Pterosiphonia pennata* (Falkenberg) Schmitz (Figures 8, 10f)**

A été trouvé dans une cuvette exposée qui reçoit continuellement le flux et le reflux de la mer, par 40 à 60 cm de profondeur, à l'ombre et sur fond sableux.

La ramification est régulière, distiche et donne à l'algue l'apparence d'une plume d'un rouge-foncé passant au noir après dessiccation. La partie rampante de l'axe est

très courte et se fixe au substratum par des rhizoïdes allongés se terminant par un disque d'adhésion.

La partie dressée atteint la hauteur de 2 à 3 cm et forme des rameaux alternes dont les inférieurs peuvent devenir à leur tour rampants et former des rhizoïdes. Les rameaux jeunes sont un peu plus courts et plus serrés. En section transversale on voit 8 à 10 cellules péricentrales, sans cortication.

Tous nos exemplaires étaient stériles, mais à notre connaissance les organes de reproduction n'ont pas encore été trouvés dans la Méditerranée.

Loc. Caesarea, 15.VI.1956; Palməhim (Wadi Rubin), 29.I.1958.

Distrib. Méditerranée occidentale; côtes atlantiques d'Europe et d'Afrique; Canaries; Australie ? (Hervey).

LE GENRE *Heterosiphonia* MONTAGNE

Caractérisé par l'organisation bilatérale de son thalle. La ramification est distique et alterne; l'axe et les rameaux secondaires sont polysiphonnés et portent de nombreux ramules monosiphonnés.

Une seule espèce sur nos côtes:

Heterosiphonia wurdemanni (Bailey) Falkenberg (Figures 9, 10g)

Assez fréquent par 40–60 cm de profondeur dans des cuvettes ombragées et battues y formant des touffes denses, hautes de 2 cm, d'une couleur rouge clair, souvent mêlées aux touffes de *Ceramium*, *Champia*, *Dasya*, etc. Une seule fois nous l'avons trouvé comme épiphyte sur *Rhodymenia*.

L'axe est libre, dressé, polysiphonné, 165–230 μ de diamètre; il forme d'une façon irrégulière des rameaux latéraux qui sont aussi polysiphonnés mais beaucoup plus grêles ne mesurant que 70 à 90 μ de diamètre.

Chaque segment de l'axe principal, de même que des rameaux latéraux, porte dans nos exemplaires un ramule monosiphonné qui se ramifie plus ou moins régulièrement par dichotomie; son diamètre est: 20–27 μ . Toutes les ramifications polysiphonnées ou monosiphonnées sont disposées d'une façon alterne et distiche. En section transversale se voient 4–5 cellules péricentrales et pas de cortication.

Nos exemplaires sont tous stériles. Cette algue ressemble beaucoup au *Dasya arbuscula* mais il y a une série de caractères qui permettent de les distinguer sans difficultés. Les plus faciles à observer sont les suivants: les ramifications de *Dasya* sortent d'une façon spiralee tout autour de l'axe (ramification radiaire); celles d'*Heterosiphonia* sortent de deux côtés opposés de l'axe (ramification distiche);

Les filaments de *Dasya* sont plus ou moins cortiqués, tandis que ceux d'*Heterosiphonia* sont toujours dépourvus de cortication.

Dans les collections du Muséum National d'Histoire Naturelle à Paris (Herbier G. Thuret) sont conservés 3 exemplaires de cette espèce, récoltés par R. Joffe à Jaffa, un en IX.1896, à côté duquel Thuret a écrit: "*Dasya wurdemanni* sur *Laurencia obtusa*"; le 2-ème en VII. 1905 et le 3-ème le 15.VII. 1905 (marqué "Callithamnion" No. 261).

Cette algue a été donc déjà récoltée sur nos côtes en 1896.

Loc. Achzib, 26.VIII.1959; Haïfa, 20.VII.1958 (15-20 fathoms); Shave Zion, 29.X. 1955; Tantara, 3.IX.1957; Caesarea, 12.VII.1953; Urim, 9.VII.1953; Jaffa, 19.VI.1956; Bath Yam, 8.V.1956 et 9.V.1957; Palmahim, 27.III.1960 et 24.VI.1958.

Distrib. Méditerranée occidentale; côtes atlantiques d'Europe, d'Afrique et d'Amérique; Canaries; Indes occidentales; Mer Rouge; Archipel Malais; Océan Indo-Pacifique; Australie.

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EPIPHYTIC ALGAE ON *HALIMEDA TUNA* f. *PLATYDISCA*
(DECAISNE) BARTON IN HAIFA BAY

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ABSTRACT

Fifty-one species of epiphytic algae recorded on *Halimeda tuna* f. *platydisca* growing in deep water in the Haifa Bay area are listed. These belong to the three main groups of marine algae, Chlorophyta, Phaeophyta and Rhodophyta. A number of epiphytic diatoms and blue-green algae previously described are also mentioned. The microzonation of most of these species is correlated with their attachment to various parts of the thallus of *Halimeda tuna*.

INTRODUCTION

The systematics and distribution of deep water algae in the Haifa Bay area formed the subject of a recent investigation in which the species recorded between depths of 10 and 50 fathoms were described (Edelstein 1960). Moreover, the same material was subsequently examined for microscopic diatoms and blue-green algae occurring as epiphytes on this substratum (Komarovskiy and Edelstein 1960).

While both reports mentioned above deal mainly with the general occurrence and distribution of the macroscopic and microscopic algal flora in that region, the present contribution attempts to list specifically the epiphytes on *Halimeda tuna*. This species was conspicuous among other algae occurring in the same rocky environment by heavy covering of epiphytes settling on its thallus almost all the year round. It is for this reason that the authors thought it advisable to devote a special contribution to this subject.

The high incidence of epiphytes observed on the thallus of *Halimeda tuna* may be ascribed to the roughness of the thallus surface of this species, thus enabling easy attachment of suitable forms. This confirms similar views expressed by other investigators (Feldmann 1937; Smith 1944; Nasr and Aleem 1949). Special mention should be made of a report on deep water algae from Eniwetok Atoll (Marshall Islands) by Gilmartin (1960) in which other species of *Halimeda* are described as particularly suitable substrata for settlement of epiphytes.

Received January 16, 1961.

Halimeda tuna f. *platydisca* (DECAISNE) BARTON AS A SUBSTRATUM FOR THE SETTLEMENT OF EPIPHYTES

Specimens collected were 15 cm long, comprising a short, thick, calcified stalk attached to the creeping system on its lower part and widening to a fan on its upper part. The fan is composed of flat, disk-like segments, 1.5 cm long and 2.5 cm wide (in the littoral form "typica", these segments are somewhat narrower). The younger segments of the plants are always terminal and dark green in colour; the older ones are yellowish-green or white, the colour depending on the degree of calcification.

Common all the year round on rocky bottom at depths of 10-20 fa.

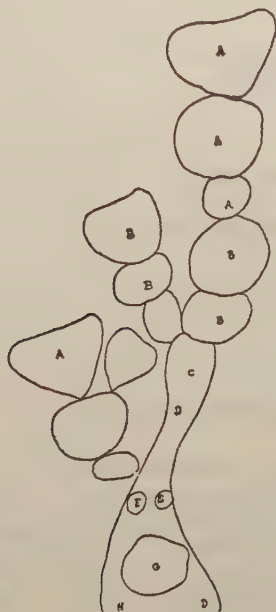


Figure 1.

A. *Liebmanna leveillei*

B. *Melobesia farinosa*

C. *Pseudolithophyllum expansum*

D. *Amphiroa rigida*

E. *Lithothamnium* sp.

F. *Peyssonnelia rubra*

G. *Peyssonnelia squamaria*

H. *Spatoglossum solierii*

THE EPIPHYTES RECORDED ON *Halimeda tuna*

The following is a list of epiphytes recorded on the thallus of *Halimeda tuna* with data on the region of attachment and seasonal distribution.

CHLOROPHYTA

Siphonocladiales

Anadyomene stellata (Wulf.) Ag.

Cladophora pellucida (Huds.) Kütz.

Region
of
attachment*

Date

l.r

VII, 1955

u.r

IX, 1955

* u.r = upper region;

l.r = lower region;

g = general

	Region of attachment	Date
Dasycladales		
<i>Dasycladus claviformis</i> (Roth) Ag.	l.r	VI, 1955
Siphonales		
<i>Derbesia tenuissima</i> (De Not.) Crouan	u.r	IX, 1955
<i>Derbesia neglecta</i> Berthold	u.r	VII, 1958
PHAEOPHYTA		
Ectocarpales		
<i>Liebmannia leveillei</i> J. Ag.	g	VI, 1956
Punctariales		
<i>Rosenvingea intricata</i> (J. Ag.) Boergs.	u.r	IX, 1956
Cutleriales		
<i>Zanardinia prototypus</i> Nardo	u.r	IV, 1956
<i>Cutleria monoica</i> Ollivier	u.r	IV, 1956
Dictyotales		
<i>Dictyota dichotoma</i> (Huds.) Lamour.	u.r	VIII, 1955
<i>Spatoglossum solierii</i> (Chauv.) Kütz.	l.r	IX, 1956
RHODOPHYTA		
Gelidiales		
<i>Gelidium pectinatum</i> (Schousb.) Mont.	l.r	IX, 1955
Cryptonemiales		
<i>Peyssonnelia squamaria</i> (Gmel.) Decsne.	l.r	IX, 1956
<i>Peyssonnelia rubra</i> (Grev.) J. Ag.	l.r	IX, 1956
<i>Lithothamnium</i> sp.	l.r	IX, 1956
<i>Pseudolithophyllum expansum</i> (Phil.) Lemoine	l.r	IV, 1956
<i>Melobesia farinosa</i> Lamour.	g	IX, 1956
<i>Amphiroa rigida</i> Lamour.	l.r	IV, 1956
<i>Callymenia reniformis</i> (Turn.) J. Ag.	l.r	IX, 1956
Rhodymeniales		
<i>Chylocladia kaliformis</i> (Good. et Woodw.) Grev.	u.r	VIII, 1955
Ceramiales		
<i>Griffithsia tenuis</i> J. Ag.	u.r	VIII, 1955
<i>Griffithsia schousboei</i> Mont.	u.r	IV, 1956
<i>Ceramium comptum</i> Boergs.	u.r	VII, 1958
<i>Ceramium gracillimum</i> Griff. et Harvey	u.r	VII, 1958
<i>Polysiphonia elongata</i> (Huds.) Harvey	u.r	IX, 1955
<i>Polysiphonia variegata</i> (Ag.) Zan.	u.r	IV, 1955
<i>Polysiphonia sanguinea</i> (C. Ag.) Zan.	u.r	IV, 1956
<i>Dasya rigidula</i> (Kütz.) Ardiss.	u.r	IX, 1956
<i>Heterosiphonia wurdemanni</i> (Bailey) Falkenb.	u.r	IX, 1956
<i>Nitophyllum punctatum</i> (Stackh.) Grev.	u.r	VIII, 1955

The following species belonging to Cyanophyta and Chrysophyta appeared as secondary or tertiary epiphytes on macroscopic algae directly attached to *Halimeda tuna*. All the species mentioned below were found on a very rich sample of *Halimeda tuna* collected in July, 1958 between stations 8 and 14 on rocky bottom at a depth of 13 fa.

CYANOPHYTA

	Substratum
Chroococcales	
<i>Xenococcus schousboei</i> Thur.	<i>Halimeda tuna</i>
Hormogonales	
<i>Calothrix confervicula</i> (Roth) Ag.	<i>Dictyota linearis</i>
<i>Lyngbya aestuarii</i> (Mert.) Liebmman	<i>Heterosiphonia wurdemanni</i>
<i>Lyngbya agardhii</i> Gom.	<i>Ectocarpus virescens</i>
<i>Lyngbya confervoides</i> C. Ag.	<i>Halimeda tuna</i>
<i>Lyngbya nordgardii</i> Wille	<i>Heterosiphonia wurdemanni</i>

CHRYSTOPHYTA

Diatomeae Pennatae

Licmophora ehrenbergii (Kütz).
Licmophora abbreviata C. Ag.
Grammatophora oceanica Ehrb.
Grammatophora undulata Ehrb.
Rhabdonemma adriaticum Kütz.
Fragilaria hyalina (Kütz.) Grunow
Synedra gaillonii (Bory) Ehrb.
Synedra hennedyana Greg.
Synedra undulata Bailey
Thalassiothrix nitzschoides Grunow
Cocconeis britannica Naegeli
Achnanthes brevipes Ag.
Achnanthes longipes Ag.
Nitzschia sigma Kütz.
Diploneis crabro Ehrb.

Substratum

Dictyota linearis
Heterosiphonia wurdemanni
Dictyota linearis
Ectocarpus virescens
Ectocarpus virescens
Heterosiphonia wurdemanni
Dictyota linearis
Heterosiphonia wurdemanni
Dictyota linearis
Heterosiphonia wurdemanni
Heterosiphonia wurdemanni
Heterosiphonia wurdemanni
Heterosiphonia wurdemanni
Ectocarpus virescens

DISCUSSION

From the data presented in the above list relating to the region of attachment of the various epiphytes to the substratum, a fairly clear microzonation becomes apparent.

Most of the small and fragile species appeared on the upper region of *Halimeda* where illumination conditions are more favourable for their growth, a view subscribed to also by Fritsch (1955). Among these species the following may be mentioned: various species of *Ceramium*, *Polysiphonia* and *Griffithsia*.

On the other hand, larger and coarser algae as well as those having a leaf-like thallus are to be found mainly on the older and more strongly calcified parts of *Halimeda tuna*. In this group mention could be made of *Pseudolithophyllum expansum*, *Lithothamnium* sp. of the heavier types and *Anadyomene stellata* and *Callymenia reniformis* of the leaf-like thallus. It can be assumed that these species adapted themselves to conditions of lower light intensity due to their weight and general form.

Only a few species of the macroscopic epiphytes appeared on the whole surface of the thallus without any preference to a particular region. They are *Melobesia farinosa* which is known as a cosmopolitan and ubiquitous form, and *Liebmannia jeveillei*.

Most of the blue-green algae reported in this investigation belong to the Hormonales and they can be described as non-selective in their choice of substratum. The same holds true for the diatoms of which only representatives of the pennate type have, so far, been found as epiphytizing *Halimeda* or other macroscopic algae attached to the latter.

Most of the microscopic species listed in this report have already been described by the authors in one of their previous contributions to the same biotope (Komarovskiy and Edelstein 1960).

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PLATE I
Various epiphytes on *Halimeda tuna*



Figure A — *Liebmannia leveillei* ($\times 1$)

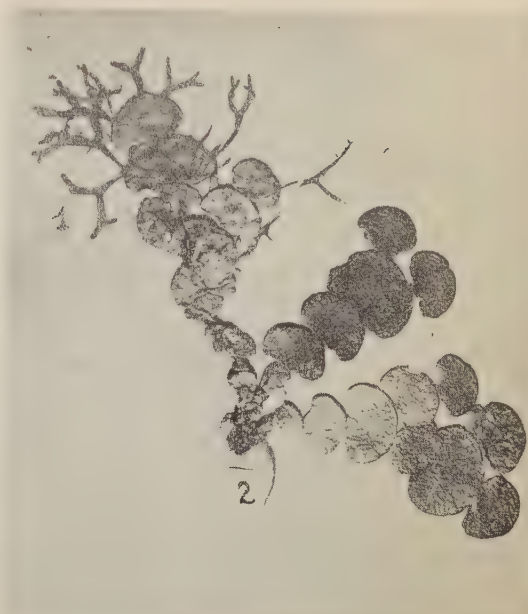


Figure B — 1. *Dictyota dichotoma*
2. *Gelidium pectinatum* ($\times 0.6$)

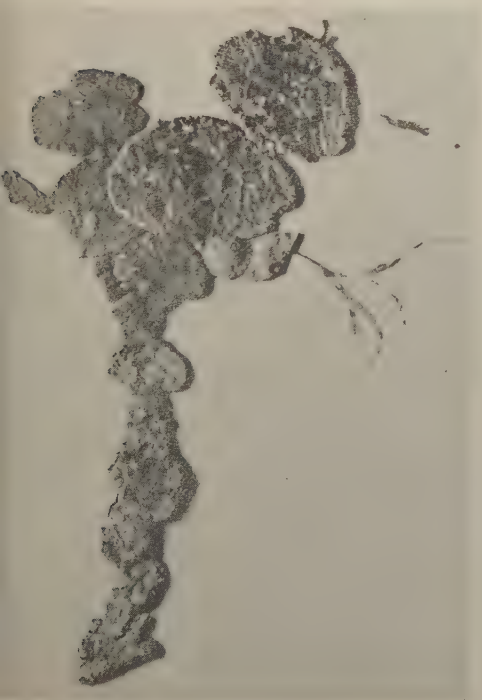


Figure C — *Griffithsia schousboei* ($\times 1.3$)

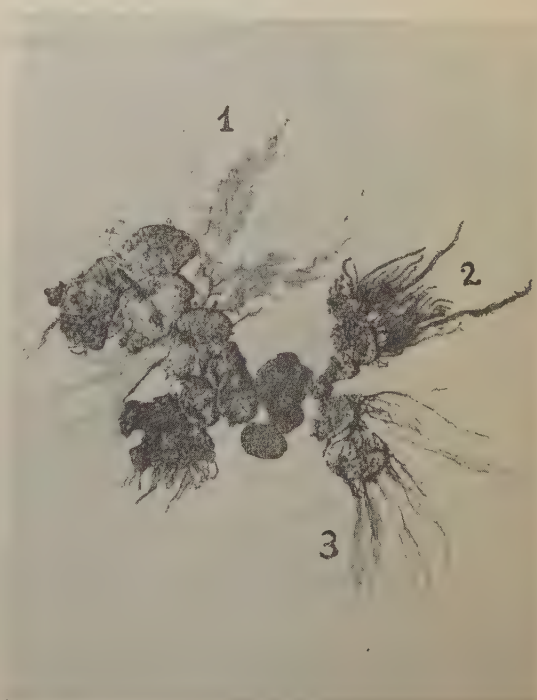


Figure D — 1. *Chylocladia kaliformis*
2. *Liebmannia leveillei*
3. *Polysiphonia elongata* ($\times 0.7$)

PLATE II
Various epiphytes on *Halimeda tuna*



Figure E — *Chylocladia kalifornis* ($\times 0.8$)



Figure F — 1. *Spatoglossum solierii*
2. *Peyssonnelia rubra* (\times)



Figure G — 1. *Polysiphonia elongata*
2. *Cladophora pellucida*
3. *Dictyota linearis*
4. *Melobesia farinosa* ($\times 0.5$)

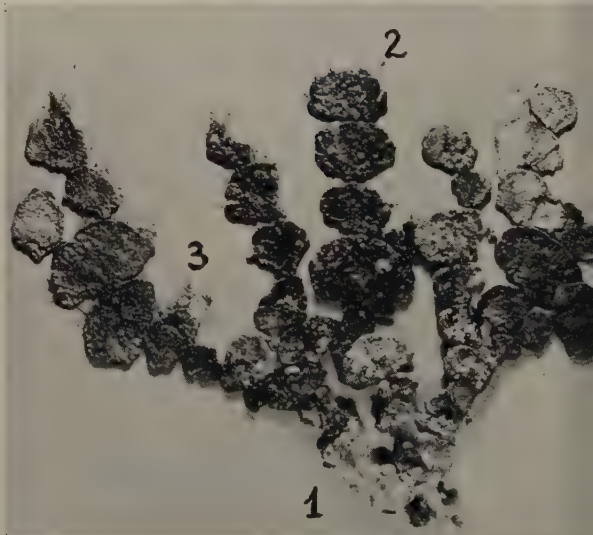


Figure H — 1. *Lithothamnium* sp.
2. and 3. *Polysiphonia* sp.
4. *Derbesia tenuissima*

PLATE III
Microscopic epiphytes

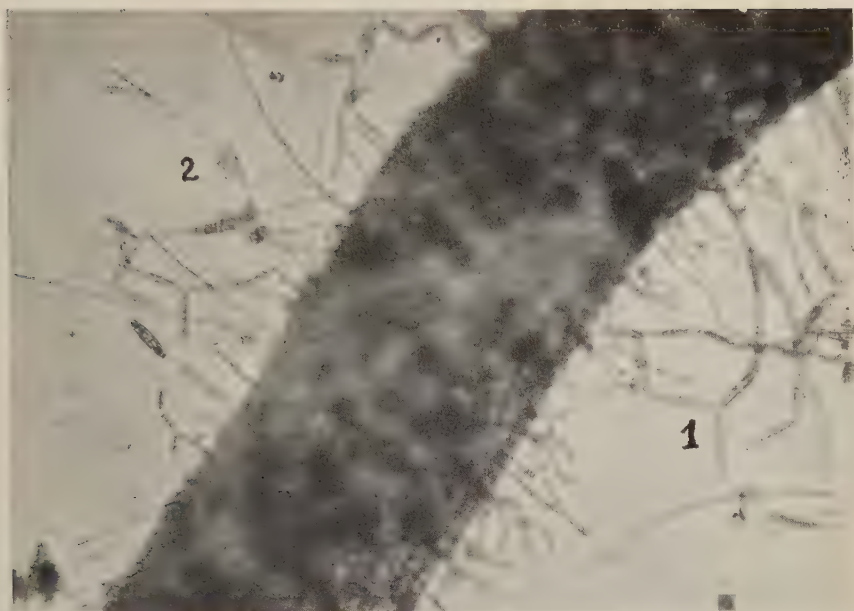


Figure I — Substratum; *Dictyota linearis* ($\times 200$)
1. *Grammatophora oceanica* 2. *Licmophora ehrenbergii*

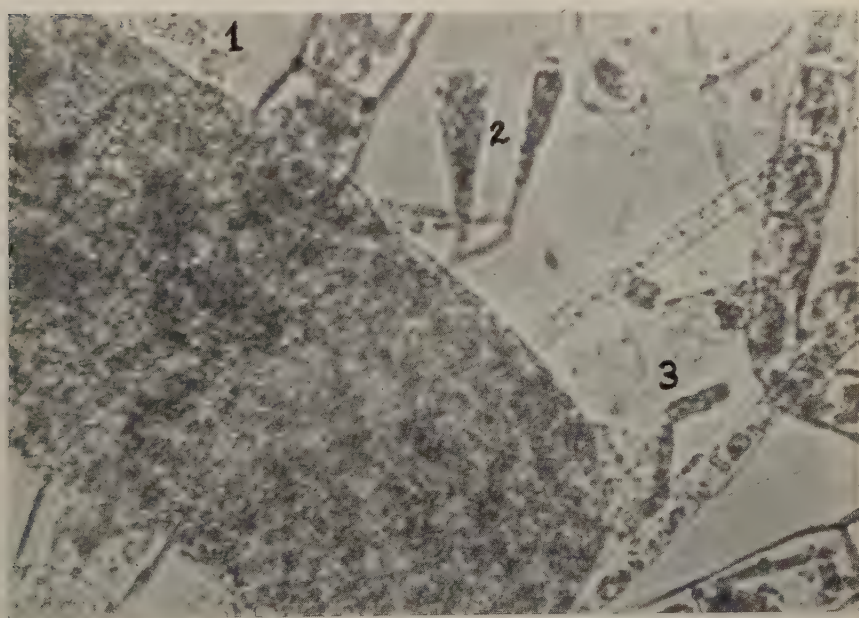


Figure J — Substratum; *Dictyota linearis* and *Ectocarpus virescens*
1. *Grammatophora oceanica* 2. *Licmophora ehrenbergii* 3. *Grammatophora undulata* ($\times 330$)

UNE NOUVELLE RHODOPHYCEE MEDITERRANEENNE
CAULACANTHUS (?) *RAYSSIAE* SP. NOV.

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RESUME

Description d'une nouvelle espèce de Rhodophycée, assez répandue dans la Méditerranée Occidentale et qui se rapproche de certaines espèces de *Caulacanthus* de l'Indo-Pacifique. Les seuls organes reproducteurs observés sont des tétrasporocystes zônés; l'absence d'organes sexués rend encore douteuse l'attribution de cette espèce au genre *Caulacanthus*.

Bien qu'ayant fait l'objet de nombreuses recherches, la flore algale de la Méditerranée est encore imparfaitement connue, et il peut arriver que des espèces parfois très répandues soient jusqu'ici passées inaperçues ou aient été confondues avec d'autres espèces.

Dans certains cas, surtout lorsqu'il s'agit de Rhodophycées, l'absence d'organes reproducteurs caractéristiques ne permet pas l'attribution précise de certaines espèces méconnues à un genre déterminé. C'est le cas en particulier de l'algue qui fait l'objet de cette note.

Découverte en 1937 sur côte des Albères (Banyuls-sur-Mer), nous l'avons retrouvée depuis dans diverses régions de la Méditerranée (Algérie, Côte d'Azur, Golfe de Naples), mais seulement à l'état de plante stérile ou de tétrasporophyte. L'ignorance où nous sommes encore de la structure de ses organes sexués nous a fait longtemps hésiter sur la position systématique à lui attribuer.

Par l'ensemble de ses caractères anatomiques et par ses tétrasporocystes zonés, elle se rapproche de certaines espèces exotiques de *Caulacanthus* et nous la décrirons ci-dessous sous le nom de *Caulacanthus* (?) *rayssiae* en hommage au Prof. T. Rayss à l'occasion de son jubilé scientifique,

***Caulacanthus* (?) *rayssiae* sp. nov.**

Caespites intricati, fusco purpurei, exsiccatione fusciscentes, rupibus expansi aut epiphytici usque ad 5 mm alti. Frondes cartilagineae cylindricae aut, pro maxima parte compressae 260-500 \times 150-300 μ , pinnatae aut irregulariter elongato-ramosae; apicibus subulatis, cellulam apicalem, septo obliquo divisam, instructae.

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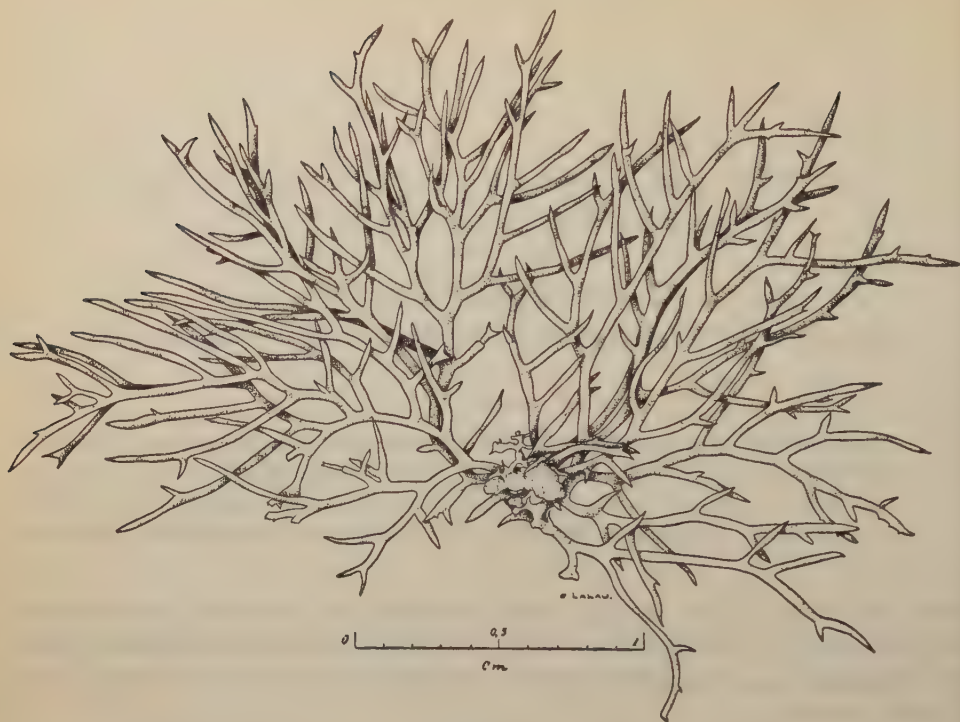


FIGURE 1

Caulacanthus (?) rayssiae sp. nov., échantillon type récolté à Banyuls-sur-Mer.

Frons axi centrali conspicua e serie unica cellularum cylindracearum duplo longiorum quam latarum et cellulis internis rotundatis dense aggregatis; stratum corticale subunistratosum et cellulis minoribus, polyedricis, coloratis, constitutum.

Tetrasporocysta zonatim divisa, elongato-ovoidea $50-55\mu$ longa et $28-30\mu$ lata, in strato corticali magis evoluta partis superioris ramorum, numerosa.

Organa sexualia ignota.

A *Caulacantho ustulato* differt ramificatione et structura solidiore.

A *Caulacantho indico* et *C. spinello*, cui structura congruit, diametro majori ramorum.

Habitat in Mari Mediterraneo adoras Galliae, Italiae et Africae borealis, prope limitem maris nec non usque ad altitudinem 25-40 m. infra superficiem maris.

Typus: Banyuls (Pyr. Or.), Ile Grosse, 12 juin 1937 leg. G. Mazoyer, No. 562 in Herb. J. et G. Feldmann.

Le *Caulacanthus (?) rayssiae* vit, dans la Méditerranée, dans des conditions écologiques assez diverses. Le plus souvent, il forme sur les rochers assez battus et ombragés, et au voisinage du niveau moyen, des gazons ras et assez denses, de couleur brun-pourpre, rappelant certains *Gelidium* gazonnants. Il peut également vivre en épiphyte sur d'autres algues, *Laurencia* en particulier. Il est en outre susceptible de se développer en profondeur, et, dans la rade de Villefranche-sur-mer (Alpes maritimes) ainsi que dans le Golfe de Naples, nous l'avons dragué entre 25 et 40 m de profondeur.

Lorsqu'il est bien développé, le *Caulacanthus (?) rayssiae* forme de petites touffes hautes de 4-5 mm (Figure 1), formées de rameaux dressés ou plus ou moins rampants

sur le substratum, cylindriques ou le plus souvent plus ou moins comprimés, de consistance cornée et de diamètre assez constant ($260-500 \times 150-300\mu$) sauf à l'extrémité atténuée en pointe aigue. La ramification abondante est irrégulièrement pennée dans tous les plans ou pseudodichotome. L'algue est fixée au substratum par un petit disque basal parenchymateux et par des disques secondaires produits à l'extrémité des courts ramules.

Par son aspect et sa consistance, l'algue rappelle beaucoup plus certains *Gelidium* que le *Caulacanthus ustulatus* bien caractérisé morphologiquement par ses nombreux ramules spiniformes courts. Au point de vue anatomique, les différences entre le *C. (?) rayssiae* et le *C. ustulatus* sont également très nettes.

La croissance du *Caulacanthus (?) rayssiae* s'effectue par une cellule initiale terminale unique, à cloisonnement oblique (Figure 3A), donnant naissance à un axe formé d'une file de cellule cylindriques produisant des rameaux formés de cellules arrondies, étroitement unies les unes aux autres et de taille décroissante vers la périphérie, où ils forment une assise corticale continue de cellules polygonales.

Contrairement à ce qui a lieu dans le *Caulacanthus ustulatus*, il semble bien que les divisions de la cellule initiale du *C. (?) rayssiae* s'effectuent selon trois plans successifs et non deux plans seulement, les rameaux latéraux issus des cellules axiales ayant une disposition tristique et non distique.

Une coupe longitudinale d'un jeune rameau (Figure 2c) montre que chaque cellule axiale donne naissance à une seul rameau latéral formé de cellules arrondies, presque isodiamétriques, cohérentes entre elles et avec les cellules des autres rameaux pour former un tissu d'allure parenchymateuse homogène.

Dans les coupes longitudinales et transversales (Figure 2, A et B) le filament axial est toujours très net et très distinct par sa membrane épaisse et son diamètre qui peut atteindre $50-70\mu$. Le filament axial est formé de cellules deux fois plus longues que larges dont les cloisons transversales sont occupées sur presque tout leur diamètre par un très large synapse. Les cellules internes de la fronde sont presque isodiamétriques et mesurent $30-50 \times 50-70\mu$ de diamètre dans la partie la plus interne; elles diminuent de taille vers la périphérie et les cellules externes, polygonales et allongées radialement, mesurent 15 à 20μ de haut et 10 à 15μ de large.

Toutes les cellules de l'algue, à l'exception des cellules axiales, sont pourvues de rhodoplastes pigmentés mais ceux des cellules internes sont filamenteux ou rubanés et de teinte plus pâle que ceux des cellules corticales fortement pigmentées et en forme de plaquettes pariétales irrégulières (Figure 3, C et D).

Nous n'avons pas observé de synapses secondaires entre les cellules. Contrairement à ce qui a lieu chez le *Caulacanthus ustulatus*, il n'y a jamais production de rhizoïdes internes, même à la partie inférieure de l'algue.

Au printemps, les rameaux jeunes portent, naissant des cellules externes, de nombreux poils hyalins unicellulaires.

Nous n'avons jamais rencontré d'individu sexué; par contre, divers échantillons récoltés en septembre à Banyuls, près du niveau, et dragués en août au Cap Ferrat

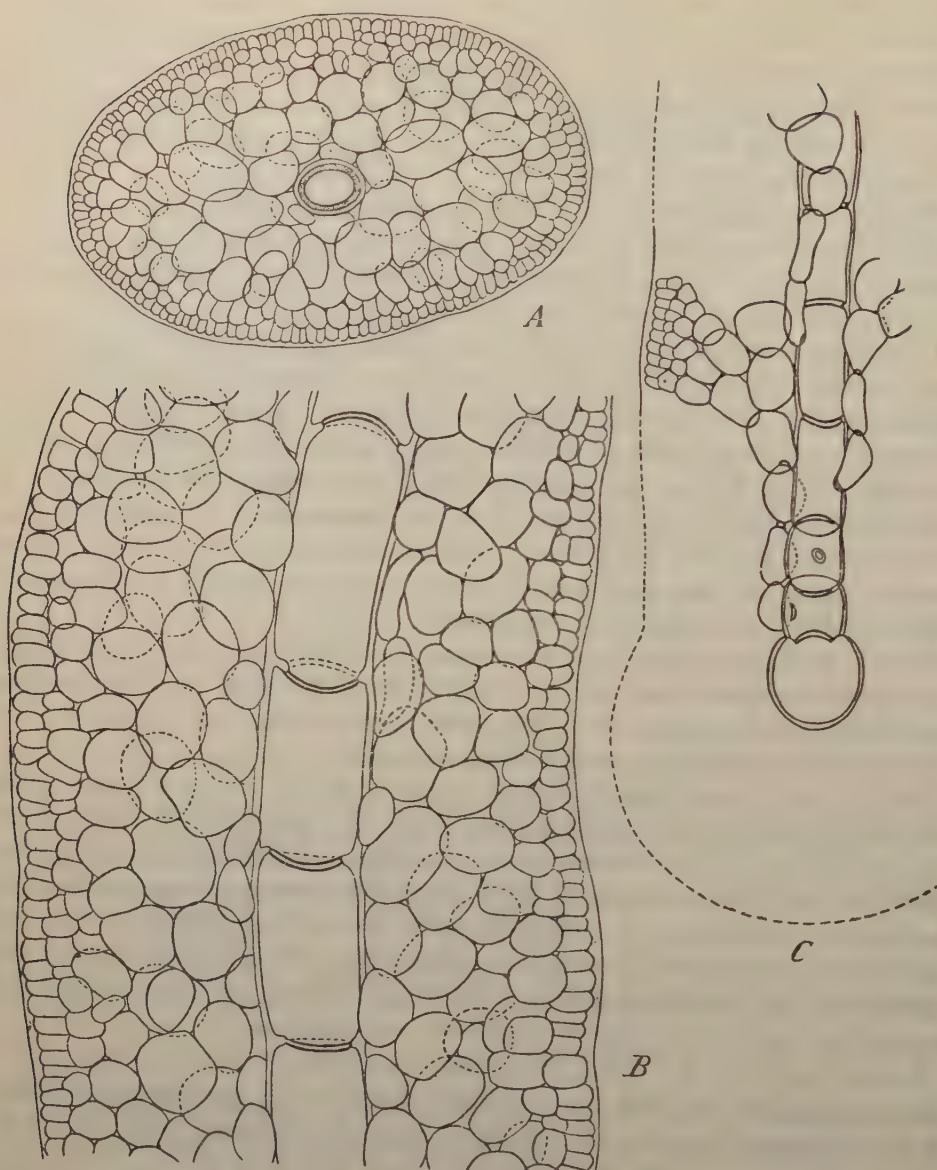


Figure 2

Caulacanthus (?) *rayssiae* sp. nov. A. section transversale d'un rameau; B. section longitudinale; C. section longitudinale d'un jeune rameau montrant l'origine des files cellulaires naissant du filament axial (A, B, C: $\times 135$).

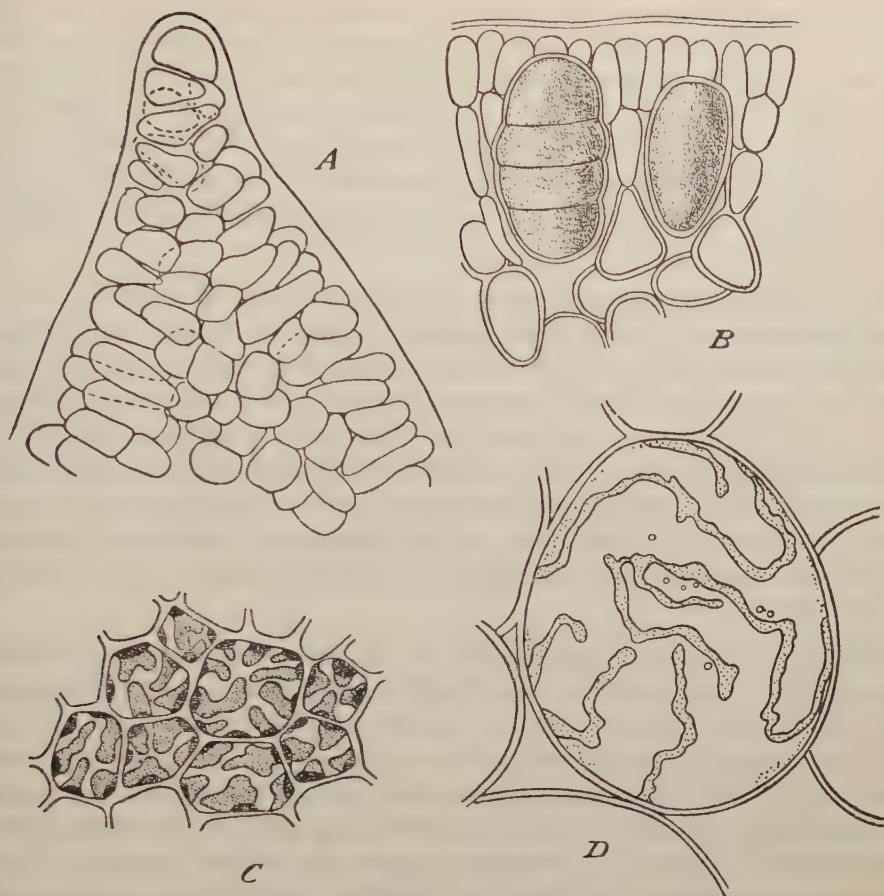


Figure 3

Caulacanthus (?) *rayssiae* sp. nov. A. sommet végétatif montrant le mode de cloisonnement de l'initiale ($\times 700$); B. tétrasporocystes ($\times 500$); C. cellules corticales avec rhodoplastes bien pigmentés ($\times 885$); D. cellule interne à rhodoplastes en bandelettes ($\times 885$).

(Villefranche-sur-Mer) possèdent des tétrasporocystes. Ceux-ci sont ovoïdes, allongés, à division zonée, mesurant $50-55\mu$ de long et $28-30\mu$ de large. Ils sont situés en grand nombre dans le tissu cortical externe des extrémités plus ou moins renflées des rameaux dressés (Figure 3, B).

Par sa morphologie et sa structure anatomique, le *Caulacanthus* (?) *rayssiae* diffère donc sensiblement du *Caulacanthus ustulatus*, type du genre. Si la cellule initiale à cloisonnement oblique et les tétrasporocystes zonés permettent de rapprocher ces deux espèces, la consistance plus cornée et la structure plus dense et d'allure parenchymateuse ainsi que le filament axial plus volumineux distinguent nettement le *C. (?) rayssiae* du *C. ustulatus*.

Le *C. (?) rayssiae* paraît présenter des affinités plus étroites avec certaines espèces exotiques rattachées au genre *Caulacanthus*, tel que le *Caulacanthus indicus* Weber van Bosse (1921) de Malaisie dont nous avons pu étudier un échantillon authentique grâce à l'obligeance du Dr. J. Th. Koster (Rijksherbarium, Leiden). Cette espèce diffère toutefois du *C. (?) rayssiae* par ses rameaux beaucoup plus grêles. Il en est de même du *Caulacanthus spinellus* (Hook. et Harv.) Kütz de Nouvelle Zélande et de l'île de Pâques dont la structure anatomique a été étudiée par Boergesen (1920, p. 280, fig. 27).

Toutes ces algues ont une structure analogue mais assez différente de celle du *Caulacanthus ustulatus*. Le genre *Caulacanthus*, longtemps placé parmi les Gélidiacées, n'a en fait aucune affinité avec les autres genres de cette famille. Il est maintenant rattaché à la famille des Sphaerococcacées (Feldmann et Hamel (1934), Feldmann (1938), Kylin (1956). D'autres familles de Gigartinales possèdent également une structure uniaxiale à cellule initiale à division oblique et des tétrasporocystes zonés: Rhabdoniacées, Rhodophyllidacées, Hypnéacées, etc. C'est peut-être des Hypnéacées que le *Caulacanthus (?) rayssiae* ainsi que les *C. indicus* et *C. spinellus* se rapprocheraient le plus. Boergesen (1950) a d'ailleurs déjà indiqué que le *C. spinellus* pourrait être un *Hypnea*.

Néanmoins, la structure de ces algues n'est pas absolument indentique à celle des *Hypnea*; le *C. (?) rayssiae* semble en particulier être dépourvu de ponctuations secondaires qui existent chez les *Hypnea*, et, en l'absence d'organes sexués (rameaux carpogoniaux et gonimoblastes) son position systématique reste douteuse. Il nous paraît donc préférable de les maintenir provisoirement dans le genre *Caulacanthus*.

Découvert par l'un de nous (G. Feldmann) sur la côte des Albères en 1937, le *Caulacanthus (?) rayssiae* y a été retrouvé depuis dans de nombreuses localités (Ile Grosse, Anse des Elmes, Cap Béar, Port-Vendres). Nous l'avons retrouvé sur les côtes d'Algérie où il est assez abondant dans plusieurs stations battues du Cap Carbon, près de Bougie ainsi que dans la Baie de Villefranche et au Cap Ferrat en dragage.

En août – septembre 1958, au cours d'un séjour à la Station Zoologique de Naples, nous l'avons observé sur des pierres draguées à Santa Lucia et sur des rochers battus de l'île de Procida.

Il semble donc que cette espèce soit assez répandue dans la Méditerranée occidentale et, en raison de ses affinités avec des espèces indopacifiques, elle serait à rechercher dans la Méditerranée orientale.

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ON THE GENUS *TRACHYCHLORON* (XANTHOPHYCEAE)

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ABSTRACT

The genus *Trachychloron* was established by Pascher (1939, p. 504–506) and recently includes 9 species. Apart from Prescott (1951) and Bourrelly and Georges (1953) no observations have been made about the occurrence of any species of *Trachychloron*. One species, *Pseudostaurastrum circulare* Bourrelly et Georges, had to be removed from the genus *Pseudostaurastrum* and placed here under the designation *Trachychloron circulare* (Bourr. et Georges) Fott comb. nov. This species is dealt with in detail and its wide distribution, perhaps cosmopolitan, is shown. Further two species of the genus *Trachychloron* have been recorded from various localities in Central Europe, occurring in plankton and benthos of small water-bodies.

The genus *Trachychloron* includes those species of coccoid *Xanthophyceae*, the membrane of which is strikingly coarse. But the coarseness of the cell-wall is not the only characteristic of the genus. A similar appearance of the membrane is displayed by the species of the genus *Arachnochloris* (Pascher 1930) from which some species were separated by the same author (1939) and transferred to a new genus *Trachychloron* Pascher. The main characteristic of the genus *Trachychloron* is an ellipsoidal habit of the cell, whereas the cells of *Arachnochloris* are perfectly spheric. In most cases the shape of cells is an ellipsoid the long axis of which is a rotation-axis (Figure 3), while in *Trachychloron circulare* its ellipsoidal cell can be derived by a rotation according to the short axis of the body. Consequently, the cells in view from above are circular (Figure 1). The coarseness of the cell-wall is due to fine network of a hexagonal system which may be hardly visible or distinctly produced as nodules.

A typical species (type-species) of the genus *Trachychloron* was not stated up to this time. It might be *Trachychloron ellipsoideum* (Pascher) Pascher, as it displays the main characteristics of the genus and its variability is well known.

The genus *Trachychloron* comprises, according to Pascher's monograph (1939), eight species. A further species was described by Bourrelly and Georges (1953) under the name of *Pseudostaurastrum*, so that nine species are known up till now. The key to distinguish the species runs as follows:

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- 1a. Only one great chromatophore
 - 2a. Chromatophore cup-shaped or laminate
 - 3a. Length of cells up to 12μ , chromatophore cup-shaped, pyrenoid basal and axial
T. simplex Pascher 1938
 - 3b. Length of cells only 7μ , chromatophore cup-shaped or lateral, channel-like
T. depauperatum Pascher 1938
 - 2b. Chromatophore cylindrical, opened on both extremities, in the middle with a cross-piece, H-shaped in optical section *T. agloë* (Pascher) Pascher 1938
- 1b. Chromatophore detached into many pieces, therefore many chromatophores in the cell
 - 4a. Chromatophores connected at one pole of the cell, here sometimes an inconspicuous pyrenoid *T. ellipsoideum* (Pascher) Pascher 1938
 - 4b. All chromatophores free, no pyrenoids
 - 5a. Cells ellipsoidal, oblong-ellipsoidal or lenticular
 - 6a. Cells without spines on the poles
 - 7a. Cells ellipsoidal along their long axis
 - 8a. Few chromatophores (4-8) *T. regulare* Pascher 1938
 - 8b. Eight to many chromatophores *T. chlorallanthoides* Pascher 1938
 - 7b. Cells ellipsoidal along their short axis *T. circulare* (Bourelly et Georges) Fott comb. nov.
 - 6b. Cells with spines on the poles *T. biverruca* Pascher 1938
 - 5b. Cells towards the poles straight attenuated, in optical section rhomboidal with rounded ends *T. biconicum* Pascher 1938

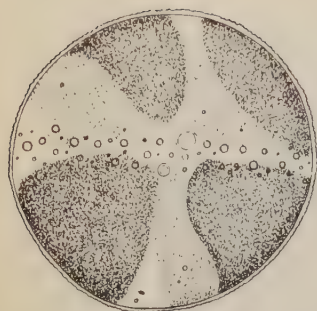
From these nine species I had the opportunity to collect and to review three species: *T. ellipsoideum*, *T. biconicum* and *T. circulare*. Here I present a short description of these species, provided with drawings and an account of their ecology and algal community in which they were recorded. Their names are in agreement with the International Code of the Botanical Nomenclature (Lanjouw 1956).

Trachychloron ellipsoideum (Pascher) Pascher (Figura nostra 3)

Heterokonten (1939), Lief. 4, 508, 1938. — Basonym: *Arachnochloris ellipsoidea* Pascher, Arch. Protistenk. 69: 412, Fig. 8. 1930 (Ikonotyp).

DESCRIPTION. Cells ellipsoidal, broadly rounded on both extremities. Membrane coarse, firm, often with a crude sculpture. Chromatophore cup-shaped with an inconspicuous pyrenoid on its bottom. The cylindrical part of the chromatophore can be divided into many pieces which appear as independent chromatophores. Dimensions of cells $10-15\mu$ in length, $8-12\mu$ in width.

The species I found in the High Tatras differed from the type by lacking the basal part of the cup-shaped chromatophore.



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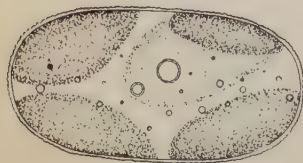
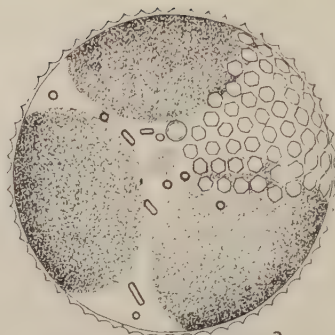


Figure 1

Trachychloron circulare (Bourr. et George) Fott, top view, and lateral view (bottom).



2

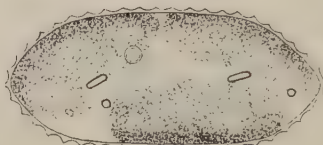


Figure 2

Another cell with a distinctly reticulated membrane.

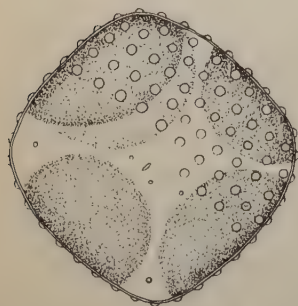


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Figure 3

Trachychloron ellipsoideum (Pascher) Pascher, lateral view (top), and top view (bottom).



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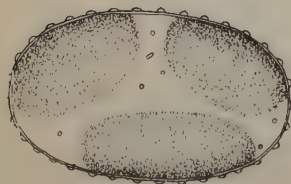
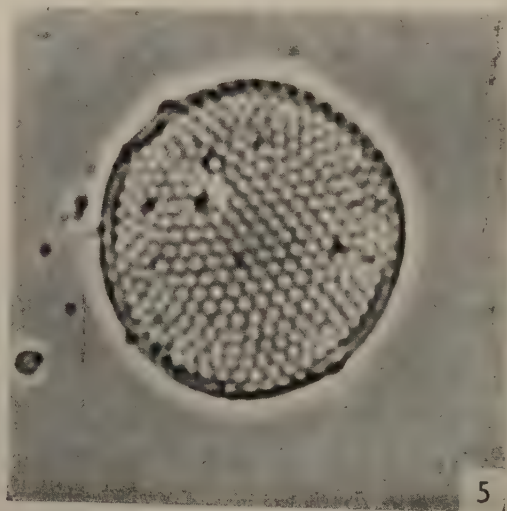


Figure 4

T. biconicum Pascher.



5

Figure 5

T. circulare (Bourr. et George) Fott (Photo J. Fiala).

Occurrence. In acid waters, ditches, peat-bogs, etc., always with a low pH. — AUSTRIA: Near Weissenstein in Steiermark. GERMANY: In a peat-bog near Georgenfeld in Sachsen. CZECHOSLOVAKIA: 1. In a small pond (the classic locality), "Pond of musicians" near Doksy (Hirschberg), leg. Pascher 1930; 2. In *Sphagnum*-bogs near Strbské pleso in the High Tatra (1350 m a.s.l.). There (4th August 1957) I found this species in the following algal-community: *Gloeodinium montanum* Klebs, *Schizochlamys gelatinosa* A. Braun, *Glaucocystis nostochinearum* (Itzig.) Rabenh., *Lepochromulina calyx* Scherffel, *Dinobryon utriculus* Stein, a fertile *Mougeotia*, *Microthamnion kuetzingianum* Nägeli, *Stephanoporus* sp., *Chrysopyxis* sp. etc. In addition many desmids and Mesotaeniales: *Cylindrocystis brebissonii* Menegh., *Netrium digitus* (Ehr.) Itz. et Rothe, *N. oblongum* (De Bary) Lütkem., *Closterium striolatum* Ehr., *Cl. nilsonii* Borge, *Tetmemorus laevis* (Kütz.) Ralfs, *Micrasterias denticulata* Bréb., *Actinotaenium cucurbita* (Bréb.) Teil., *Cosmarium pseudopyramidatum* Lund., etc. (leg. et det. Dr. J. Ružička).

Trachychloron biconicum Pascher

(Figura nostra 4)

DESCRIPTION: Cells in fact ellipsoidal-tetrahedral, but conical towards the poles and rhomboidal in optical section. Both extremities broadly rounded. Membrane thick, mostly scrobiculate. Chromatophores variable in number and size. Occasionally only one large parietal chromatophore, in some cases 2–3, sometimes numerous, discoid. Reproduction by means of autospores (according to Pascher). Dimensions mostly 14 μ (8–20 μ).

Occurrence: In neutral or alkaline waters, usually on limestone. — AUSTRIA: Back-waters of the Traun near Ischl (leg. Pascher). CZECHOSLOVAKIA: Ponds on limestone near Prague in Radotin (leg. Pascher). In a pond (Brve) near Prague, floating in plankton. This pond, watered by springs arising from the cretaceous sandstone, was inhabited (15th September, 1956) by following plankton-community of Algae: *Scenedesmus bijugatus* (Turp.) Kütz. and spec. div., *Tetrastrum* spec. div., *Treubaria triappendiculata* Bernard, *Chodatella quadriseta* Lemmer. *Dictyosphaerium pulchellum* Wood, *Siderocelis ornata* Fott, *Quadricoccus laevis* Fott, *Planctonema lauterbornii* Schmidle, *Oocystis coronata* Lemmer. etc. POLAND: In a small fish-pond near Giżycko (18th September, 1958) with a plankton community of *Microcystis flos-aquae*, *Pandorina morum* Bory, *Pediastrum duplex* Meyen, *Scenedesmus quadricauda* (Turp.) Bréb. and other Chlorococcales, *Lepocinclis steinii* Lemmer., *Dinobryon divergens* Imhof, *Goniochloris fallax* Fott, *Centritractus belonophorus* Lemmer. *Tetragoniella gigas* Pascher, etc.

Trachychloron circulare (Bourelly et Georges) Fott comb. nov. (Figurae nostrae 1,2,5)

BASONYM: *Pseudostaurastrum circulare* Bourelly et Georges, Oesterr. bot. Zeitschr. 100: 503, Fig. 10, 1953 (lc. prima).

DESCRIPTION: Cells ellipsoid, flattened, lenticular, as their short axis is the rotating axis of the ellipsoidal body. Membrane fine, smooth or structured, punctate, scrobiculate or reticulate, showing regular hexangular fields. Chromatophores usually 4, disciform, parietal, pale-green. Store-product oil droplets and small granula, accumulated mostly in a median plane (Figure 1). Reproduction not observed. Dimensions: 7–15 μ , thickness of cells: 2.5–5 μ .

VARIABILITY: The size of cells is lenticular. The diversity appears in cross section which may be elliptical or sexangular (Figures 1,2). The old cells may be invaginated, like the xanthophycean genus *Chlorogibba*. The surface of membrane in young cells is quite smooth and no structure can be seen even when using a strong magnification. On other cells a fine punctuation of membrane can be distinguished. A regular net-work of sexangular fields is discernible on desiccated cells especially when they have been carefully burned like diatoms. The membrane of *Trachychloron circulare* is slightly silicified and its sexangular net-work is similar to the membrane-structure of *Coscinodiscus*. The number of chromatophores seems to be mostly 4; in old cells, however, its number rises to 10 or even more. In some cells they are disciform. In favourable cases the nucleus is discernible in the middle of the living cells.

TAXONOMY. Bourrelly and Georges (1953) observing the reticular structure of the cell-wall were of the opinion that the species belonged to the genus *Pseudostaurastrum* Chodat sect. *Goniochloris* (Pascher) Bourrelly, as the membrane shows the same areoles as in *Goniochloris sculpta* Geitler. But the reticular structure of the cell-wall is very common in many genera of Xanthophyceae (*Arachnchloris*, *Chlorallanthus*, *Chlorogibba*, etc.), and this characteristic only is not sufficient to place this Alga in a correct genus. The creating of a large genus *Pseudostaurastrum* Chodat in Bourelly (1951) containing many sections (*Tetraedriella*, *Tetrakentron*, *Tetragoniella*, *Isthmochloron* and *Goniochloris*) seems to bring no progress in the taxonomy of Xanthophyceae and was criticised by Fott and Komárek (1960, p. 210).

OCCURRENCE and ECOLOGY: *Trachychloron circulare* is a very common alga having doubtlessly a cosmopolitan spread. It occurs in pools, ponds and shallow eutrophic lakes and can be detected only in centrifugated samples. The localities of *Trachychloron circulare* are very diverse in appearance and can be best characterised by giving the algal community in which the Alga occurs.

FRANCE (Bourrelly and Georges 1953, p. 500): In a pond near Rambouillet, overgrown with *Potamogeton natans* and *Myriophyllum spicatum*; the pH of water is neutral; the plankton-community contains: *Ceratium hirundinella* (O.F.M.) Schr., *Euglena oxyuris* Schmarda et spec. div., *Trachelomonas armata* (Ehr.) Stein et spec. div., *Eudorina elegans* Ehr., *Cosmarium meneghinii* Bréb., *C. granatum* Bréb., *Staurastrum furcigerum* Bréb. etc. HUNGARY: 1. In a fish-pond near Sarosfő (17th August, 1957) in the community of Algae: *Coelastrum sphaericum* Nägeli (the most abundant), *Dictyosphaerium pulchellum* Wood, *Dimorphococcus lunatus* Braun, *Pediastrum* spec. div., *Siderocelis ornata* Fott, *Quadricoccus verrucosus* Fott, *Crucigenia apiculata* (Lem.) Schmidle, *Tetragoniella gigas* Pascher, *Goniochloris fallax* Fott, *Ceratium hirundinella* (O.F.M.) Schr., *Gonyostomum latum* Ivanov, *Trachelomonas* spec. div., etc. — 2. In the lake Belső-tó (19th August, 1957) the plankton community was composed of *Microcystis flos-aquae* and numerous Chlorococcales, e.g. *Dictyosphaerium pulchellum*, *Pediastrum* spec. div., *Tetraedron minimum* (A. Br.) Hansg., *T. caudatum* (Corda) Hansg., *T. triangulare* Korsh., *Scenedesmus* spec. div., *Ankistrodesmus angustus* Corda, some Flagellates (*Gonyostomum latum* Ivanov) and Xanthophyceae (*Tetragoniella gigas* Pascher and *Goniochloris fallax* Fott). — Lake Balaton near Keszthely (26th August, 1957): *Lyngbya circumcreta* G. S.

West, *Pseudanabaena catenata* Lauterb., *Planctonema lauterbornii* Schmidle, *Gomphosphaeria lacustris* Chodat, *Aphanizomenon gracile* Lemmer., *Phacotus lenticularis* Ehr., *Dictyosphaerium ehrenbergianum* Näg., *Oocystis lacustris* Chodat, *Coelastrum reticulatum* (Dang.) Senn, *Cryptomonas* sp., *Euglena oxyuris* Schmarida, etc. GERMANY: 1. Grosser Uklei-See is a small forest-lake, the plankton of which is characterised by predominance of Cyanophyceae (*Gomphosphaeria lacustris* Chod., *G. rosea* [Snow] Lemmer.) and Flagellates (*Ceratium hirundinella*, *Phacotus lenticularis*, *Pandorina morum*) above green-algae (*Pediastrum duplex* Meyen, *Ankyra judai* [Smith] Fott, *Coelastrum reticulatum* [Dang.] Senn, *Schroederia robusta* Korsh., *Staurostrum* sp.) and Diatoms (*Asterionella formosa* Hassall, *Rhizosolenia longiseta* Zach., *Stephanodiscus* sp.). — 2. Molfsee near Kiel has an appearance of a pond, measuring only 34 ha; its maximum depth is 7 m, but the average depth is only 3–4m. It belongs to the so-called Chroococcales-lakes (Apstein 1884, 1886, p. 95, 102) and really on 26th September 1957 the plankton was inhabited by a cyanophycean community of *Microcystis flos-aquae* (Wittr.) Kirchn., *M. viridis* (A. Braun) Lemmer., and *M. incerta* Lemmer. In addition, there were some nannoplankton Algae, some of them recorded for the first time in Germany: *Tomaculum catenatum* Whitford (syn. *Dictyochloris reniformis* Korshikov), *Goniocloris mutica* (A. Braun) Fott, *Siderocelis ornata* Fott, *Pediastrum kawraiskyi* Schmidle et spec. div., *Tetraedron minimum* (A. Braun) Hansg., *Planctonema lauterbornii* Schmidle, etc. POLAND: 1. Lake Dgat maly near Giżycko (17th September, 1958). Plankton community: *Dinobryon bavaricum* Imhof, *Dictyosphaerium pulchellum* Wood, *Pandorina morum* Bory, *Scenedesmus* spec. div., *Planctonema lauterbornii* Schmidle, *Melosira granulata* (Ehr.) Ralfs, etc. — 2. Small fish-pond near Giżycko. The plankton-community was dominated by a flat *Gymnodinium* sp., by *Melosira granulata*, *Mallomonas fastigata* Zach., and *Dinobryon divergens* Imhoff. In addition to *Pandorina morum* Bory, *Euglena acus* Ehr., *Kephyriopsis entzii* (Conrad) Fott, *Codonomonas urceolata* Fott, *Tetragoniella gigas* Pascher, *Goniocloris fallax* Fott, *Catena viridis* Chod. and some Chlorococcales. CZECHOSLOVAKIA 1. Pond Palach II near Lednice (7th April, 1959). In disturbed water of the very small pond only bottom diatoms and small Xanthophyceae were found, e.g. *Goniocloris fallax* Fott, and *G. mutica* (A. Braun) Fott. — 2. Ponds near Blatná in Bohemia. These fish-ponds display either blooms of Blue-greens (*Anabaena flos-aquae* Bréb., *A. spiroides* Kleb., *Microcystis flos-aquae* [Wittr.] Kirchn., e.g. pond Radov) or a coloration of water, due to the nannoplankton of Green-algae and Flagellates, e.g., pond Dolejší. The dominating genera are as follows: *Ankistrodesmus*, *Pediastrum*, *Oocystis*, *Siderocelis*, *Crucigenia*, *Trachelomonas*, *Chlamydomonas*, *Pteromonas*, *Cryptomonas*, etc.

ACKNOWLEDGMENTS

As a study of the small Xanthophyceae can be performed only in live state and with laboratory equipment, my research was done in the biological stations, situated in regions with a rich algal-flora. My thanks are due to the Managements of these institutions: Biological Research Institute in Tihany (Hungary), Hydrobiologische Forschungsanstalt in Plön (Germany), Institute for Fishery and Hydrobiology in Giżycko (Poland), Biological Station in Lednice and Biological Station of the Charles University near Blatná (both Czechoslovakia). I am also indebted to Mr. J. Fiala for a photo of *Trachychloron* and Mrs. E. Truncová for inking my drawings and for technical assistance.

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CINEMICROGRAPHY OF SPERMATOZOIDS AND FERTILIZATION IN FUCALES

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ABSTRACT

Spermatozoid movement and some stages of fertilization in *Ascophyllum nodosum* and *Halidrys siliquosa* were recorded by cinemicrography and single frames were subsequently analyzed. Movement of the sperm flagella, changes in the shape of the sperm cell and the attachment of the front flagellum to the egg surface were studied. In *Haliarys* the attached flagellum is surrounded by a small cone-like protuberance of the egg cell surface.—The oogamy of Fucales and of some other orders in Phaeophyceae is comparable with the oogamy of *Prasiola*. It is presumed that a similar submicroscopic mechanism exists in both cases, involving the elastic properties of the flagellar and cell surface membrane.

INTRODUCTION

Recent investigations on the oogamy of *Prasiola stipitata*, using a combination of light microscopy, cinemicrography and electron microscopy (Friedmann 1960, Manton and Friedmann 1960) have shown that in this green alga one of the sperm flagella establishes the first contact with the egg cell. The membrane of the flagellum first coalesces with the surface membrane of the ovum and then, apparently by the elastic contraction of the membrane, the flagellum penetrates the egg plasma and thereby the two cells are brought together till their protoplasts fuse.

This seemingly peculiar process resembles in some way the oogamy of Fucales and suggests that a similar submicroscopic mechanism might be involved in the oogamy of Phaeophyceae. At this stage, it was not possible to investigate in detail the problems of Phaeophycean fertilization as it was done in the case of *Prasiola* and the present communication is but the outcome of a preliminary attempt to record some steps in the fertilization of Fucales by cinemicrography.

ACKNOWLEDGEMENTS

The cinemicrographic work was carried out in 1959 in the Botany Department of the University of Leeds, England, during the tenure of a D.S.I.R. Senior Visiting Fellowship in 1959. The author's sincere thanks are due to the head of the Department, Prof. I. Manton, for her manifold help and encouragement during the investigations and to Mr. A.D. Greenwood (at present Imperial College, London), for his very valu-

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able guidance in cinemicrography. Mr. K. Oates' expert technical assistance is gratefully acknowledged.

MATERIAL AND METHODS

Ascophyllum nodosum and *Halidrys siliquosa* were collected at Cullercoats (Yorkshire). The 16mm. cinemicrographic equipment of the Botany Department of the University of Leeds was designed by Mr. A.D. Greenwood.

OBSERVATIONS

Ascophyllum nodosum (L.) LeJol.

A spermatozoid in motion as photographed through the phase contrast microscope is shown in Plate I which represents a continuous sequence of 14 cine frames (frequency: 16 frames/sec.). The accompanying line drawings are traced after the cinemicrographic frames.

The spermatozoid is guttiform (drop-shaped) and this is how spermatozoids appear immediately after liberation from the antheridia. In several of the figures in Plate I the apical, half-funnel shaped proboscis (Manton and Clarke 1950, 1951, Manton, Clarke and Greenwood 1953, Manton and Clarke 1956) is clearly visible. The proboscis is rather difficult to observe in swimming spermatozoids. The photographs reveal that while in motion their shape is similar to that shown in the electron micrographs of Manton.

The continuous sequence of cinemicrographic frames reproduced in Plate I gives some information about the movement of sperm flagella. There is a conspicuous difference between the front and the hind flagellum. The former exerts rapid undulating movements. The frequency of cine frames was not high enough to resolve the frequency of these undulations, which thus must be = or > 16/sec. The hind flagellum, in turn, remains erect during swimming, and it was not possible to determine with certainty whether or not, in this stage of free swimming of the spermatozoids, it actively participates in the movement. Rather it appears to be merely trailing behind the cell. Plate III, Figure 1 shows an egg with numerous spermatozoids swarming around it, adhering to its surface and rotating it. This corresponds to the well known picture of Fucacean fertilization in the classical drawings of Thuret and Strasburger. Plate III, Figure 2 shows three eggs, somewhat flattened under the pressure of the cover slip. Only a few spermatozoids were added in order to facilitate focusing on individual sperms. Prior to fusion, they are slowly crawling over the egg surface. Their shape is no longer guttiform, as in the first, free swimming period, but more elongated and comma-like. The hind part of the cell body forms the long tapering end of the comma, and the spermatozoid arches in a characteristic way over the egg surface. In this position the spermatozoid slowly advances forward, i.e. in the direction of the front flagellum.

Plate II is a series of 8 cine frames covering a time span of 1/2 sec., which shows spermatozoids as they appear shortly before fertilization. In the absence of eggs,

they adhere by the tips of their front flagella (which appear thus to be sticky) to the surface of the cover slip. The cells show a comma-like shape similar to that of the spermatozoid on Plate III, Figure 2. Their posterior portion is elongated, tapering, and the whole cell body is arched like the spermatozooids on the surface of an egg. The front flagellum shows an undulating motion as in the free swimming stage. The hind flagellum is erect, although a comparison of individual photographs of this cinematographic sequence clearly shows its slow swinging motion. The proboscis is visible mainly in the upper and middle spermatozoid. The comparison of these photographs with Plate III, Figure 2, leads to the conclusion that the concave side of the arch is turned towards the egg surface and thus the proboscis faces the egg during the crawling of the spermatozooids on and their attachment to the surface of the egg.

Plate III, Figure 3 is a single frame showing a spermatozoid attached to the egg by the anterior flagellum. In this late stage, the spermatozooids swim or gyrate around their attached front flagellum. The film did not show whether the spermatozooids are propelled by the movement of the front or the hind flagellum. Neither could the proboscis be photographed at this stage.

***Halidrys siliquosa* (L.) Lyngb.**

Plate III, Figure 4 is a single cinemicrographic frame showing a spermatozoid attached to the egg surface. The spermatozoid is gyrating slowly around the point of attachment.

A similar stage is shown in Plate IV, Figures 1 and 2. These are photographs of a specimen killed by osmic vapour. In two different foci, they show the same spermatozoid attached to the egg surface by the front flagellum.

Judging from its length, this is apparently partly immersed into the egg plasma, while the hind flagellum is out of the photographic focus. At the point of attachment, the egg surface forms a small cone-like protuberance. It is uncertain, however, whether this protuberance indicates the actual entrance of the spermatozoid into the egg plasma or else a reversible attachment of the flagellar tip to the egg surface.

Both the cine- and the photomicrographs show that the *Halidrys* spermatozooids retain, in contrast to *Ascopyllum*, their guttiform shape in the early stages of fertilization.

DISCUSSION

The present preliminary investigations demonstrate the value of cinemicrographic recordings and the evaluation of single frames in the study of flagellar movement and fertilization whenever rapidly changing details escape visual observation.

In the spermatozooids of *Ascopyllum nodosum*, the rapid undulating movement of the front flagellum and the very slow swinging of the erect hind flagellum could be demonstrated. Also, the changes in shape of the sperm were recorded. Prior to fertilization the spermatozooids change from the initial drop-shape of the

free swimming stage into an elongated comma-like shape with a tapering, beak-like end. The proboscis was photographed during swimming. The problem of the role of the proboscis in fertilization as raised by Manton, Clarke and Greenwood could not be settled. It was merely made very probable that in spermatozoids which crawl over the egg surface and attach themselves to it by their front flagellum, the proboscis is turned towards the egg. It should be noted, however, that this situation was recognized by Thuret in *Fucus* as early as 1857: "Les antherozoides s'appliquent à la surface de la spore dans le sens de leur longueur. Ils sont placés un peu obliquement, le rostre (i.e. the proboscis) dirigé vers la spore, à laquelle ils paraissent se fixer par leur cil antérieur."

The attachment of the front flagella to the cover glass indicates that an apparently non-specific stickiness of the flagellar tip establishes the first contact between sperm and egg surface.

In *Halidrys*, the attachment of the front flagellum to the egg surface was similarly demonstrated and thus the early observations of Farmer and Williams (1898) could be confirmed. In *Halidrys* spermatozoids, no change is taking place in the cell shape prior to fertilization. The flattening of the *Ascophyllum* spermatozoid might perhaps be connected with the presence of a proboscis in this organism which is, in turn, lacking in *Halidrys*.

The attachment of the anterior sperm flagellum to the egg surface as the first step in fertilization does not seem to be confined to Fucales among the brown algae. The following reports compiled from the literature rather indicate that very probably an essentially similar phenomenon does occur in a number of other Phaeophyceae orders.

Ectocarpales:

<i>Ectocarpus siliculosus</i> (Dillw.) Lingb.	Berthold, 1881
	Sauvageau, 1896 b
	Sauvageau, 1896 c
	Hartmann, 1937
<i>Ectocarpus secundus</i> Kütz.	Sauvageau, 1896 a
	Sauvageau, 1896 c
<i>Scytosiphon lomentaria</i> (Lyngb.) Ag.	Berthold, 1881
<i>Colpomenia sinuosa</i> (Roth) Derb. et Sol.	Kunieda and Suto, 1938

Sphacelariales:

<i>Cladostephus spongiosus</i> C. Ag.	Schreiber, 1931
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Dictyotales:

<i>Dictyota dichotoma</i> (Huds.) Lamour	Williams, 1904
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Fucales:

<i>Fucus serratus</i> L.	Thuret, 1857
	Thuret et Bornet, 1878

<i>Fucus spiralis</i> L. var <i>platycarpus</i> (Thur.) Batt.	Strasburger, 1884
<i>Fucus vesiculosus</i> L.	Strasburger, 1884
	Levring, 1947
<i>Halidrys siliquosa</i> (L.) Lyngb.	Farmer and Williams, 1898
<i>Cystoseira barbata</i> J. Ag.	Knapp, 1931
<i>Pelvetia canaliculata</i> (L.) Decsne. et Thur.	Subrahmanyam, 1958

In Ectocarpales, the gametes of both sexes are released as planogametes, but the ♀ retracts its flagella before fertilization to function physiologically as an egg.

Thus fertilization in most (though not in all) recorded cases in Phaeophyceae is essentially oogamy and the first step in fertilization so far observed is the attachment and subsequent penetration of the front flagellum of the sperms into the egg. This phenomenon resembles the oogamous fertilization in the green alga *Prasiola stipitata* Suhr (Friedmann, 1960, Manton and Friedmann, 1960), although in the case of *Prasiola* the two flagella of the spermatozoid are isokont and it is only during the actual fertilization process that they fulfil different physiological functions. The analogy in the external morphology of fusion suggests a submicroscopic mechanism in Phaeophyta similar to that known in *Prasiola*, involving the coalescence of the flagellar membrane with the egg body membrane and the penetration of the flagellum into the egg plasm leading to the fusion of the protoplasts. Evidently, in the Phaeophyta this requires further investigation. A case in point is Manton's recent (1959) research on the spermatozooids of *Dictyota*, which showed that before spermatozoid liberation, the coiled flagella lay "without any trace of separate membranes of their own" in the sperm plasm. After the emergence of the flagellum, "the flagellar membrane can be nothing other than a part of the body membrane which has been up-lifted". The unity of flagellar and body membranes, the apparently easy mutual shifting of flagellar body (core) and membrane, and the elastic properties of the latter displayed during the emergence of the flagellum from the cell, support the presumption indicated above.

On the other hand, for the time being, no interpretation can be put forward concerning the small cone-like protuberance which surrounds the submerging flagellum in *Halidrys*, though the possibility cannot be ruled out that this phenomenon is also connected in some way with the elastic properties of the surface membrane. There is no indication whether or not these cones develop into a "fertilization cone" similar to that described in *Cystoseira barbata* J. Ag. by Knapp (1931) and in *Coccolophora Langsdorfii* (Turn.) Grev. and *Sargassum tortile* C. Ag. by Abe (1941). In these cases the "fertilization cone", similar to the fertilization cone in Metazoa, indicates the spot where the spermatozoid penetrated the egg. The cone-like protrusion in *Halidrys*, however, is either the first, irreversible step in the actual fusion of gametes or it might indicate a reversible attachment of the sperm flagellum to the egg surface. It is also uncertain whether this cone-like protrusion is identical with the "conical projections" described by Farmer and Williams (l.c.) in *Halidrys* which should

appear on the egg surface immediately *after* fertilization.

It should be stressed, finally, that by pointing out the similarity between the mechanisms of oogamous fertilization in *Prasiola* on the one hand and in several Phaeophyceae genera on the other, it is not suggested that this analogy might be interpreted as an indication of phyletic relationship between Schizogoniales (*Prasiolales*) and Phaeophyta. On the contrary, it seems to show that a certain physiological mechanism is not necessarily confined to a single taxonomic group.

SUMMARY

Early stages in the fertilization of *Ascophyllum nodosum* (L.) LeJol. and *Halidrys siliquosa* (L.) Lyngb. and spermatozoid movement in *Ascophyllum* were recorded by cinemicrography. Enlarged prints of single frames were compared and analyzed. In *Ascophyllum nodosum* the movement of the anterior flagellum is a rapid undulation, whereas the hind flagellum is erect and displays a slow swinging only. The proboscis was photographed in swimming spermatozooids. The spermatozooids are guttiform after liberation and elongated, comma-shaped before fertilization. The attachment of the front flagellum on the egg surface as the first step in fertilization, already described for various Phaeophyceae, was cinemicrographically recorded. — In *Halidrys siliquosa* the egg surface forms a small cone-like protuberance around the attached front flagellum. In contrast to *Ascophyllum*, no change in cell shape takes place in the spermatozoid prior to fertilization.

Oogamy in Fucales and other Phaeophyceae orders morphologically resembles the oogamy in *Prasiola*. In *Prasiola*, it is known to start with the coalescence of the surface membranes of both sperm flagellum and egg and is probably in some way due to the elastic properties of the surface membrane. There is ample indication that the whole mechanism of sperm attachment and penetration might be similar in both cases.

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Plate I.

Ascophyllum nodosum (L.) LeJol. Photographic prints of a continuous sequence of 14 cine frames showing a free-swimming guttiform spermatozoid. The proboscis is apparent in frames 5, 6, 7 and 9. (Cf. line drawings traced after the photographs). Phase contrast, 16 frames/sec. The left halves of the cine frames are only reproduced, right halves omitted. The line drawings on the transparent paper are traced after the photographs. Dotted line: reconstruction of segments of flagella and proboscis not in photographic focus.

1



2



3



13



5



6



10



14



3



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9



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7



11



4



8



12





Plate II.

Ascophyllum nodosum (L.) LeJol. Photographic prints of a continuous sequence of 8 cine frames showing 3 spermatozooids which attached themselves to the slide by the tip of the anterior flagellum. Note the undulating movement of the posterior flagella. The tips of the front flagella remain in a fixed position (however, the flagellar tip of the upper spermatozoid is shifted very slightly). Cell shape is elongated, comma-like with a tapering end and arched, similarly to the spermatozoids crawling over the egg surface (Plate III, Figure 2). The proboscis of the upper and middle spermatozoid is apparent in several frames. Phase contrast, 16 frames/sec.

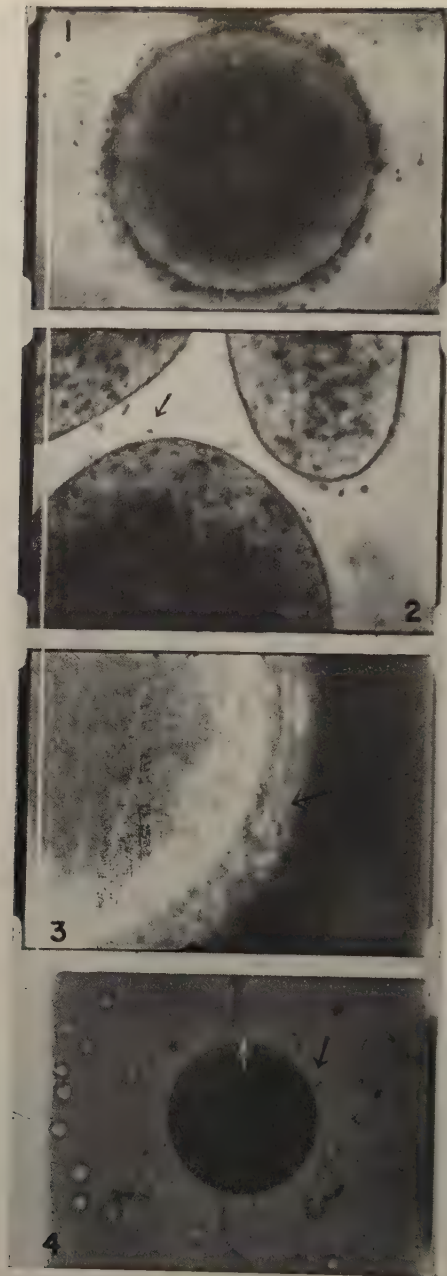


Plate III.

Figures 1-3: *Ascophyllum nodosum* (L.) LeJol. Single cine frames showing early steps in fertilization. Figure 1: An egg with numerous spermatozooids swarming around. Figure 2: Spermatozooids crawling over the egg surface. The shape of spermatozooids is comma-like, elongated and they arch over the egg surface. The spermatozoid indicated by arrow crawls to the right, its tapering posterior end is pointing to the left (cf. Plate II, especially lower spermatozoid). Figure 3: A spermatozoid attached to the egg surface by the anterior flagellum (indicated by arrow). Figure 3: Phase contrast. Figure 4: *Halidrys siliquosa* (L.) Lyngb. Photographic print of a cine frame showing a guttiform spermatozoid (indicated by arrow) attached to the surface of an egg.

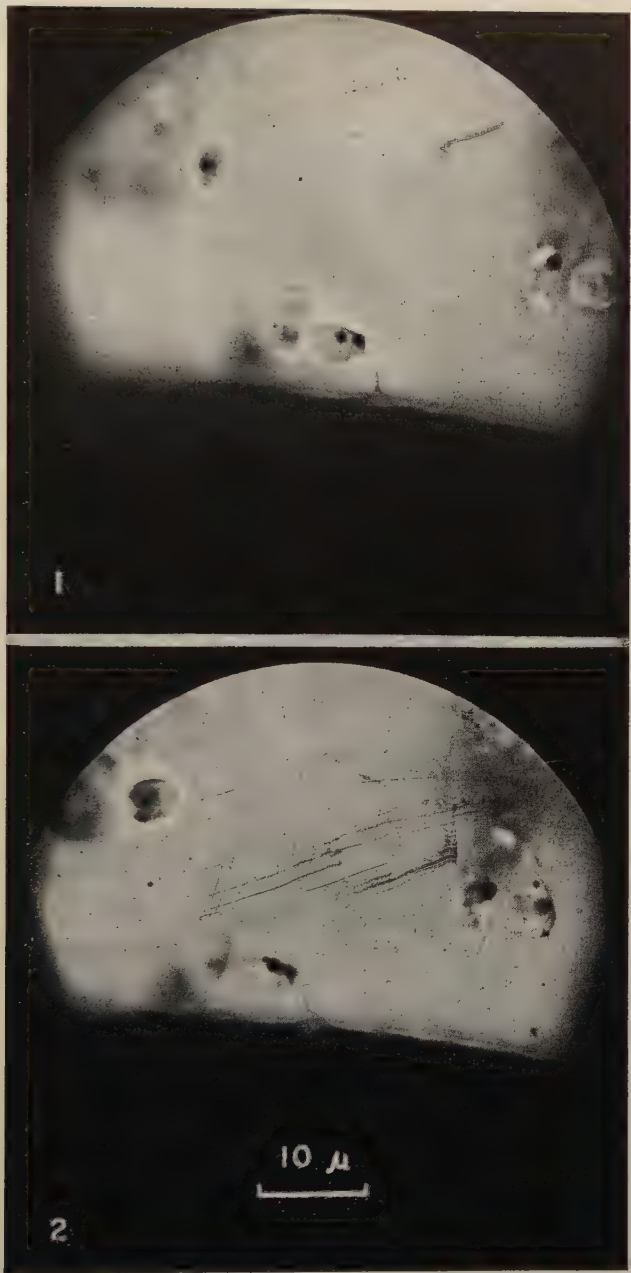


Plate IV.

Halidrys siliquosa (L.) Lyngb. A spermatozoid attached to the egg by the anterior flagellum. The submerged tip of the flagellum is surrounded by a small cone-like protuberance of the egg surface. Figures 1 and 2 represent different photographic foci of the same cell. Photomicrograph, cells killed by osmic vapour.

SUDDEN INCREASE OF THE PLANKTON IN THE ZOHAR RESERVOIR*

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ABSTRACT

Algal counts of the water in the artificial Zohar Reservoir in the Negev revealed an unexpected algal bloom starting in October 1958. It transpired that this bloom coincided with the introduction into the reservoir of large quantities of fish. Large numbers of *Synechocystis* and other *Cyanophyceae* then appeared. The bloom was reduced, at least temporarily, by application of algicide, and possibly also by the replenishment of the reservoir with water from Rosh Ha'ayin.

Lake Zohar is an artificial, unlined reservoir in the northern Negev, with a maximum capacity of 7 million cubic meters for the storage of water from Rosh Ha'ayin springs. It was first filled early in 1958. Samples of water from Lake Zohar were analyzed for plankton content by the Sanitary Engineering Laboratories at Kiryat Hatechnion on 36 dates, between the 14.4.1958 and 25.3.1959. The surface and depth samples were collected every two weeks at the centre of the Lake, and near the tower, close to the intake and also along the shore near the dam.

THE SAMPLING AND COUNTING METHODS

1) Collection

Samples were collected with a "Furst" water sampler at 30 cm below surface and at 1 meter above the lake bottom and were conveyed from the field to the laboratory in 1.5 litre plastic jars.

2) Centrifuging

Within 24 hours of arrival, 40 ml of each sample were thoroughly shaken and concentrated in a Servall Centrifuge (operating at 2400 r.p.m.) to 4 ml and fixed by the addition of commercial Formaldehyd (40%) so that the resulting concentration of Formaldehyd in the concentrated sample was 4%.

3) Counting

1 ml of each concentrated sample was pipetted into a Sedwig Rafter counting cell and examined at a magnification of 100-150. Ten field counts were made with the

* The present paper, based on researches carried out by the author while a member of the academic staff of the Technion-Israel Institute of Technology, presents one phase of the research project carried out by the Sanitary Engineering Laboratories, Kiryat Hatechnion, Haifa, at the large artificial reservoir of Lake Zohar in the Negev. The project was carried out at the request of "Mekorot" and will be the object of a more comprehensive report.

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aid of a Whipple disco-micrometer and the observed species were recorded on bench sheets, showing the commonest species in the various planktonic groups (Diatoms, Chlorophyta, Cyanophyta, Dinoflagellata).

4) *Recording of results*

The total number of organisms and that of each species per ml was then calculated according to the formula (1):

$$F = \frac{\text{No. fields in 1 ml counting cell (1 mm deep)}}{\text{No. fields counted}} \times \frac{\text{ml of concentrate}}{\text{ml water in original sample}}.$$

The necessary calibration was made for the microscope.

STATISTICAL ANALYSIS

The counts made on samples taken on the same day at different points on the lake (excluding the shore) and at different levels show differences of as much as 100%.

The counts were performed on samples taken on 36 different dates yielding total concentrations of algae varying from 50 per cc (on 6.8.1958) to 44, 375 per cc (on 11.2.1959).

A comprehensive statistical analysis of the data for the 26 samples taken on 10 separate dates (from 16.12.1958 to 25.3.1959), when large amounts of algae were present, reveal the following averages (in algae per ml), at the centre of the reservoir and at the tower:

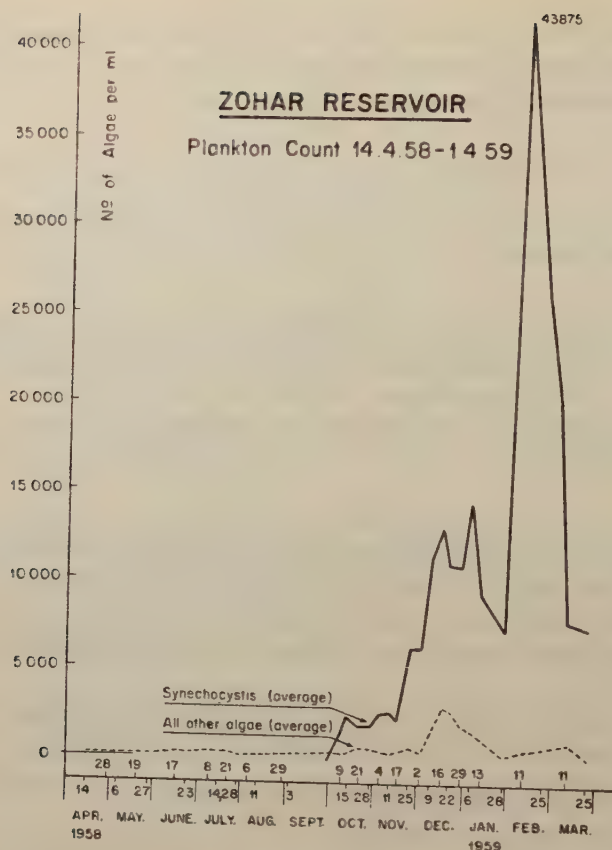
18700 (ten counts)	centre-surface
16900 (ten counts)	centre-depth
23800 (three counts)	tower-surface
16200 (three counts)	tower-depth.

A similar trend is observable on the 26 other dates when less algae were present.

It may be assumed that there are 10-20% less algae in depth than at the surface. However these conclusions may be over hasty because on 4 out of the 10 dates considered above, there were more algae in depth than in surface at the centre of the lake, and on one of those occasions (on 30.12.1958) there were 16000 algae in the depth sample and 9000 in the surface sample.

As not enough data are available for differentiating between samples at different depths, the attached table and graph have been established by simply taking the average of all available results for each day of sampling.

It was found expedient to distinguish between the number of *Synechocystis* and those of all the other species together. The results are collated in this manner in the following graph and Table I.



Three periods can be clearly distinguished:

1. *First period:* April 1958 to September 1958. When the reservoir was filled for the first time the observed algae were mainly diatoms and chlorophyceae. The total concentration of algae was low. During this whole period the number of algae per ml never exceeded 300.

2. *Second period:* October 1958 to Mid-February 1959. In the beginning of October 1958 there occurred an algal bloom and the concentration of algae increased from 300 per ml on 1.10.1958 to 44375 per ml on 11.2.1959. Most of the increase is accounted for by the appearance in the water of large masses of *Synechocystis* of which no trace had been observed during the first period. Other *Cyanophyceae* also appeared in large numbers. However, in the first half of December 1959 there is a considerable bloom of *Navicula* which had also been present in the lake during the first period.

3. *Third period:* Mid-February to end of March 1959. During the last phase of the investigations, the concentration of algae declined from 44375 per ml on

TABLE I
ZOHAR RESERVOIR — RESULTS OF PLANKTON EXAMINATIONS

	14.4 1958	28.4	6.5	19.5	27.5	17.6	23.6	8.7	14.7	21.7	28.7	6.8	11.8	29.8	3.9	1.10	9.10	15.10	21.10	28.10	4.11	11.11	17.11	25.11	2.12	9.12	16.22	22.12	29.12	6.1 1959	13.1	28.1	11.2	25.2	11.3	25.3		
<i>Navicula</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
<i>Cymbella</i>	+	+		+	+		+				+								+	+																		
<i>Scenedesmus</i>	+	+	+	+	+	+	+	+	+	+	+			+	+	+		+	+	+	+		+	+	+	+												
<i>Cyclotella</i>						+	+								+	+																						
<i>Coelastrum</i>									+						+	+																						
<i>Ankistrodesmus</i>						+			+							+	+				+																	
<i>Synedra</i>	+															+	+	+		+																		
<i>Nitzschia</i>				+				+			+							+	+	+														+				
<i>Oscillatoria</i>													+					+	+	+																		
<i>Amphora</i>																	+		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		
<i>Anabaena</i>															+					+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		
<i>Merismopedia</i>						+	+		+	+				+						+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
<i>Peridinium</i>															+		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
<i>Crucigenia</i>																																						
<i>Protococcus</i>										+																												
<i>Nodularia</i>																			+																			
Others	+	+			+	+	+	+	+	+	+	+	+	+	+	+		+		+	+	+	+		+	+	+	+	+	+	+	+	+	+	+	+	+	
Total	75	70	60	50	80	260	180	280	240	200	60	50	75	235	215	290	130	330	595	525	350	310	410	610	385	110	2915	2750	1875	1685	1125	185	500	40	910	60		
<i>Synechocystis</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	10	1405	2295	1825	1880	2905	2585	2215	6240	6275	11600	12875	10875	10750	14500	9250	7250	43875	25625	6775	7280		
Grand total	75	70	60	50	80	260	180	280	240	200	60	50	75	235	215	300	1535	2625	2430	2405	3255	2895	2625	6850	6660	11710	15790	13625	12625	16185	10375	7435	44375	25665	7685	7340		

11.2.1959 to 7340 per ml on 25.3.1959. The *Synechocystis* still constituted about 99% of the algal population through the period under consideration.

The decrease in algal concentration was due in all probability to the application of algicide (copper sulphate) and possibly also to dilution resulting from the introduction of fresh water from Rosh Ha'ayin springs.

CONCLUSIONS AND COMMENTS

During the first period the algal count was low and the water was of good quality, in spite of the fact that the reservoir was being filled for the first time. The algal bloom which occurred during the second period was detrimental to water quality. It may be noted that this algal bloom, which occurred at a time when no additional water was being brought into the lake, coincided with the introduction into the lake of large numbers of Tilapia and Carp. In the absence of other known changes in the environment it seems reasonable to assume that the bloom was related to the introduction of the fish. *Synechocystis* is known (2) to be usually present in large quantities in fish ponds and it made its first appearance in Lake Zohar shortly after the introduction of the fish. Usually *Synechocystis* hangs on the gills of the fish. The decrease in the plankton population which was observed during the end of February and March 1959 was possibly due to the concurrent effect of the application of an algicide and of the dilution of the water by the addition of quantities of fresh water from Rosh Ha'ayin springs.

ACKNOWLEDGMENT

My appreciation goes to Prof. A. M. Wachs, Head of the Sanitary Engineering Laboratories, under whose guidance this work was carried out, and to the staff of those Laboratories, especially to Mr. B. Sless, who helped in the editing of this text. Thanks are also due to "Mekorot" who permitted publication of data on this aspect of the Zohar Reservoir study.

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ON THE DELINEATION OF SPECIES OF CYANOPHYCEAE

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ABSTRACT

Increase of material, during a century, has given the students of Cyanophyceae a chance to reconsider their conception of species. It is suggested to make the delineation of species not too narrow, in several cases, considering the possible influence of environmental conditions and morphological variability. Some aspects about the situation in other cryptogamic groups are illustrated by means of quotations.

During the first three quarters of the 19th century Meneghini, Kützing, Rabenhorst, Naegeli, C. and J. G. Agardh, Harvey, Montagne, and other algologists described many new species of Cyanophyceae which appeared different from the few species described before. These authors were right to do so, because due to lack of sufficient material for study, they could not know whether their new species were connected or not by transitional forms to earlier described species.

Bornet and Flahault (1886–1888) and Gomont (1892), having much material at their disposal, considerably extended the delineation of most species in their monographs of filamentous Cyanophyceae. They brought a great many of the species known at that time into the synonymy of others. To *Lyngbya aestuarii* (Mert., Liebm. ex Gom. (16, p. 127–131) we find added 41 synonyms, to *Gloeotrichia pisum* (Ag.) Thuret ex Born. et Flah. (4, p. 366–367) 31 synonyms. Geitler (1930–1932, p. 1052), in one of his excellent works on Cyanophyceae, remarked under his description of *Lyngbya aestuarii*, which is rather similar to Gomont's and as to the measurements exactly the same: "Sicher eine Sammelart!", but omitted Gomont's formae of this species. To *Gloeotrichia pisum* (p. 632), where also Bornet and Flahault's description is more or less followed and exactly so as to most of the measurement Geitlers, added: "Wohl als Sammelart aufzufassen, welche in eine grosse Zahl von Formen und Varietäten zerfällt." As we may feel in "Sammelart" a certain disapproval, we come to the conclusion that Geitler thought the delineation of the species concerned too broadly conceived, thought no change was proposed.

The same author (p. 149) concluded that only the size of the cell is reliable as a distinguishing character in *Aphanocapsa*. When using his key for that genus (p. 151) we feel uncertain about that character as well, in case our *Aphanocapsa* cells have a diameter of about 6μ :

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Zellen 4-8 μ gross.	
Zellen 5-8 μ gross	<i>A. Roeseana</i> 15.
Zellen kleiner.	
Zellen 6-7 μ gross, Lager mikroskopisch klein, auf Schnee.....	<i>A. nivalis</i> 16.
Zellen 4-7 μ gross	<i>A. biformis</i> 17.
Zellen 3,2-5,6 μ gross.	
aërophytisch	<i>A. Grevillei</i> 18.
submers	<i>A. pulchra</i> 19.
Zellen kleiner als 4 μ , etc.	

As a rule the delineation of species of Cyanophyceae cannot be made too narrow, since the exact influence of the external conditions on the colonies and the individual cells is not known, nor is this the case with the morphological variability in all its extent. Here is quoted the conclusion to which Hof and Frémy (1932-33, p. 157) came after studying Cyanophyceae living in brines: "Comparing these results with the forms mentioned above as *Dzensia salina* Woron., *Aphanothece halophytica* Frémy and *Aphanocapsa litoralis* Hansg., we find an almost complete transition from *Aphanocapsa* — *Dzensia* — *Aphanothece**. It seems, therefore, in this case, just as arbitrary to bring the forms to one genus (whether *Dzensia*, *Aphanothece* or *Aphanocapsa*) as to give different names to the colonies observed. It seems equally profitable to classify Bacteria according to their morphology. Only single-cell cultures would give us the proof. And single cell cultures of these and similar algae have failed. The only conclusion we can reach with any degree of justification would be that there occur in concentrated brines a number of bluegreen algae belonging to the Chroococceae. The shape of the cell, its colour, the ability to form sheaths and common matrices seems to be exceedingly variable."

Yet most algological taxonomists may not desire to go as far as Van Niel (1955 p.98), who stated: "seems to lead to the conclusion that the problem of speciation in the bacteria — and, by similar reasoning, this would apply equally to the bluegreen algae — has not been solved, and that the recent work on variability and induced mutations has led us back to the stage before Cohn's contributions, when an almost unlimited variability was accepted."

The monographer, who studies as much of the collected material obtainable (among which are the types), has the best opportunity to get the most complete view of the known species with their variability.

Drouet and Daily (1956), after having studied an enormous number of living and dried material of the coccoid Cyanophyceae, reduced the number of described species to a great extent, bringing numerous species into the synonymy with others. To *Anacystis montana* f. *montana* (p. 45-52) are added 337 (also nomenclatural) synonyms. But, even after doing so, in a few cases they had difficulties in finding

* Drouet and Daily (1956, p. 29, 103) brought *Dzensia salina* Woron. and *Aphanothece halophytica* Frémy into the synonymy of *Coccochloris elabens* (Bréb.) Drouet et Daily, and *Aphanocapsa litoralis* into the synonymy of *Entophysalis deusta* (Menegh.) Drouet et Daily.

essential distinguishing characters, as appears from their key for *Entophysalis** (p. 102–103):

- | | |
|---|---------------------|
| 1. Marine | 2. |
| 1. Freshwater | 4. |
| 2. On rocks, wood, and shells | <i>E. deusta</i> |
| 2. On larger algae and living animals | 3. |
| 3. | |
| 4. On rocks, wood, and shells | <i>E. rivularis</i> |
| 5. On larger plants | <i>E. Lemaniae</i> |

When identifying an *Entophysalis* from brackish water, growing on rocks, wood or shells, we are doubtful whether to bring it to *Entophysalis deusta* or to *Entophysalis rivularis*.

Fan (1956, p. 15) in his monograph on *Calothrix* has reduced the number of 23 species we find described by Bornet and Flahault (1886–1888, p. 345–347) to 6. Unfortunately, we cannot see from the first part, all that is published so far, where the remaining species and, moreover, the later described ones have gone, but the species delineation of *Calothrix* must have been extended considerably.

In the Cyanophyceae the environmental influence may cause differences, which, of course, are not essential for distinguishing separate species. Jaag (1945, p. 40) concluded his study on the influence of different light intensities on one of the Scytonemataceae, which he had placed in his collection of living algae under the name of *Tolypothrix distorta* var. *penicillata*, with the following: "Wir möchten darum mit der endgültigen Beschreibung der Alge zuwarten, bis wir über ihr Verhalten verschiedenen Aussenbedingungen gegenüber vermehrte Kenntnisse gesammelt haben. Um aber inskünftig über die Alge in klarer, verständlicher Weise diskutieren zu können, bezeichnen wir sie vorläufig als *Scytonema polymorphum* nov. sp. Diese Bezeichnung wählen wir mit Rücksicht auf die verschiedenartigen Erscheinungsformen, die sie unter abgestuften Belichtungsverhältnissen hervorbringt."

Students of other groups of algae have the same experience, as may be realized from Starr's paper on *Cosmarium turpinii*, where the author states in the beginning (1958, p. 243): "An overwhelming number of species, varieties, and forms of desmids have been described but many are highly suspect as environmental variants which have been recognized as taxonomic entities."

For fungi the case seems to be similar or worse, as we may learn from Von Arx's paper (1957, p. 422–434) on *Colletotrichum* in which he mentions a parasitic phyco-

* Dr. Fr. Drouet wrote about this key in a letter (5 Febr. 1960): "We had tried to substitute a key separating the species on morphological bases, but it became so involved that we retained the key separating the species on the basis of habitats simply because it was the most clear and useful."

mycete, *Glomerella cingulata*, with 624 synonyms, since in the past this species was described over and over again from all of its different phanerogamic hosts.

These lines have been written in honour of Professor Rayss, who may have met difficulties in identifying Cyanophyceae, herself, during her study of that group in her country.

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THE PYRAMIMONAS-LIKE MOTILE STAGE OF *HALOSPHERA VIRIDIS* SCHMITZ

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ABSTRACT

The *Pyramimonas*-stage of *Halosphaera viridis*, interesting phylogenetically, is described. It possesses trichocysts or muciferous organelles, two or four pyrenoids covered by starch sheaths, and a large internal reservoir connected to the exterior by a narrow canal. This canal-reservoir system may be comparable with the gullet found in the cellulose-walled genus *Platymonas* and is reminiscent of the reservoir in the Euglenophyceae and the gullet in the Cryptophyceae.

An unusually delicate and beautiful green flagellate was isolated from temporary cultures set up from seawater samples taken off the coast of Devon, England, in July 1958. From the internal structure of this organism, as seen with the light microscope, it was at first thought that it could very properly be placed in a new genus instead of in the genus *Pyramimonas* to which it appears most closely related. But since this paper was sent to the press we have discovered that the form described in it is not an independent species but a stage in the life-history of the problematic *Halosphaera viridis*. Regretfully we must therefore refer to this form as the *Pyramimonas*-stage of *Halosphaera*, instead of naming it in honour of Prof. T. Rayss, as was originally intended. Its structure indicates that the genus *Halosphaera* will have to be removed from the Xanthophyceae. Any discussion, either on the position occupied by this *Pyramimonas*-stage in the life-history of *Halosphaera*, or on the different morphological types of motile-stage that have been recorded for *Halosphaera*, would be futile until the complete life-history has been elucidated.

DIAGNOSIS OF *Pyramimonas*-STAGE OF *Halosphaera viridis*

Cellula erratica periplasto distincto hyalino circumscripta, satis metabola, conica vel pyramidoïdes vel obtuse obovata, 4 vel 8 costis longitudinalibus in cellulis maioribus interdum manifestis, (14) 18–24 (28) μ longa, in parte latiore (10) 12–18 (22) μ diam., in lobos anticos truncatos, in cellulis maioribus magis manifestos foveam cingentes producta. Flagella 4 (interdum 2) tenuia, cellula 1.5–2 plo longiora, seorsum ex media fovea orientia; cuius fundus ductu brevi angusto cum gula conjunctus postica sphaerica 5–10 μ diam., granula fulva vel aurantiaca 0.5–4 μ diam., saepe foveante, fungendi modo ignoto.

Revised MS. received November 10, 1960.

Chromatophorum viride, urniforme, in lobos anticos cellulae prolongatum, postice interdum quadrifidum, pyrenoïda 2 vel 4 infra bases loborum fovens depresso globularia vel ovalia, testis amyleis bivalvis circumdata, 3–6 μ diam. Nucleus in viva cellula conspicuus, ovoidens 5–7.5 μ longus, ante gulam superficiei appropinquatus. Stigma aurantiacum, lunulare vel fusiforme vel bacillare, 1.5–2 μ longum, 0.5–0.75 μ latum, in facie exteriori chromatophori postice situm. Corpora mucifera ejectilia sphaerica vel pyriformia, 1–1.5 μ diam., in strato externo cytoplasmatis distributa, series parum manifestas formantia. Planta num solum phototropa?

Propagatio vegetativa in statu erratico bifissione effecta, cellulis filialibus plerumque aequalibus, in statu sedentario fissione iterata, cellularum serie filamentis simili proveniente.

Typus die 9. Jul. 1958 in summo mari lat. bor. 50°06' long. occ. 04°21' lectus, in Plymouth Angliae sub numero 205 cultus, postea in vivario Cantabrigiensi depositus.

Motile cell with distinct clear periplast, showing considerable metaboly; cone-shaped, pyramidiform or truncate ovoid, larger cell sometimes showing 4 or 8 longitudinal costae, (14) 18–24 (28) μ in length, (10) 12–18 (22) μ in breadth at widest part; the 4 anterior body lobes, more obvious in larger cells, with flattened extremities, surrounding a basin-shaped depression. Four (occasionally 2) flagella, delicate, 1½–2 times body length, arising separately from centre of anterior depression; short narrow canal opening into depression and connecting a spheroidal reservoir, 5–10 μ in diameter, lying inside the body towards the posterior pole, to the exterior; yellow gold to orange red granules, 0.5–4 μ , frequently present in reservoir; function of reservoir unknown.

Chloroplast green, urn-shaped, passing into anterior body lobes, sometimes with four slits in posterior part to give a four-lobed appearance: pyrenoids lying in chloroplast below junction of lobes, depressed globose to ovoid, 2 or 4, each with a two-sectioned starch sheath, 3–6 μ in diameter. Nucleus visible in living cell, ovoid, 6–9 μ in length, lying excentrically in body anterior to the reservoir. Stigma, orange red, crescent-, spindle-, or rod-shaped, 1.5–2 \times 0.5–0.75 μ , on outer face of chloroplast close to posterior end. Ejectile muciferous organelles, spheroidal to pyriform, 1–1.5 μ diameter, distributed, apparently in rows, in peripheral cytoplasm. Nutrition phototrophic only?

In motile phase asexual reproduction by fission into two daughter-cells, usually of equal size; in non-motile phase by fission in a palmelloid pseudo-filamentous stage (?).

Habitat. The sea at position lat. N. 50°06', long. W. 04°21' [9 July 1958 (type culture Plymouth no. 205) and 26 August 1958] at surface and at position lat. N. 50°02', long. W. 04°22' [9 July 1958] at 5 m. Type culture at the Laboratory of the Marine Biological Association, Plymouth and also deposited with the Culture Collection of Algae and Protozoa, Cambridge.

DESCRIPTION OF *Pyramimonas*-STAGE OF *Halosphaera viridis*

The mode of swimming of this *Pyramimonas*-stage of *Halosphaera* is not the characteristic type of movement of a sudden stop and start nature shown by the greater number of the smaller marine *Pyramimonas* species. It swims for only short distances in one direction and changes direction by changing the position of the flagella. Swimming is rapid with rapid rotation of the body and with the point of origin of the flagella either in front or behind the body (Figures 15–17). There is more gyration when the flagellar pole is foremost, the cell swimming with the flagella lying backwards down the side of the body (Figures 15, 17) and the flagellar tips about level with the posterior end of the cell. More usually this motile-stage swims with the flagellar end foremost, but, it is frequently seen directed backwards (Figure 16), and, if cells collide, they quickly sweep the flagella to either behind or down the

EXPLANATION OF PLATE

Pyramimonas-stage of *Halosphaera viridis* Schmitz

(Fig. 7, $\times 2335$; Figs. 1-4, 8-9, $\times 1250$; Figs. 5-6, 10-11, 13-14, $\times 750$; Fig. 12, $\times 375$)

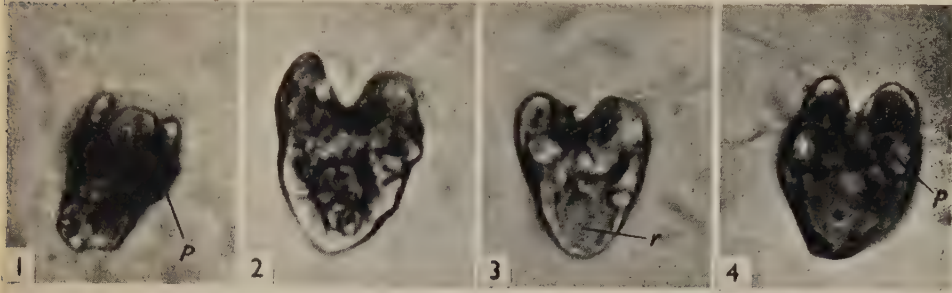
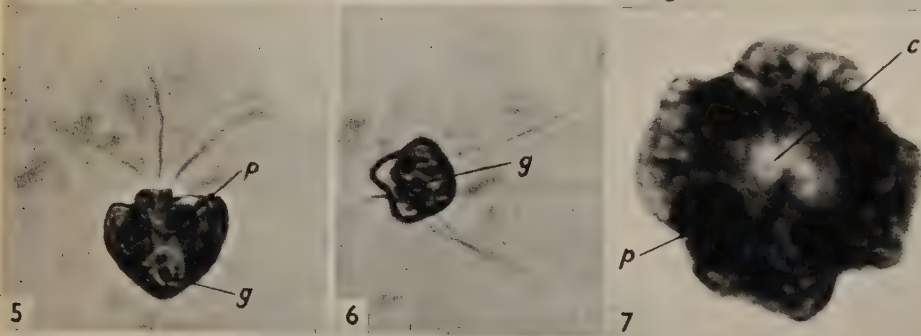


Fig. 7 |————| 10 μ

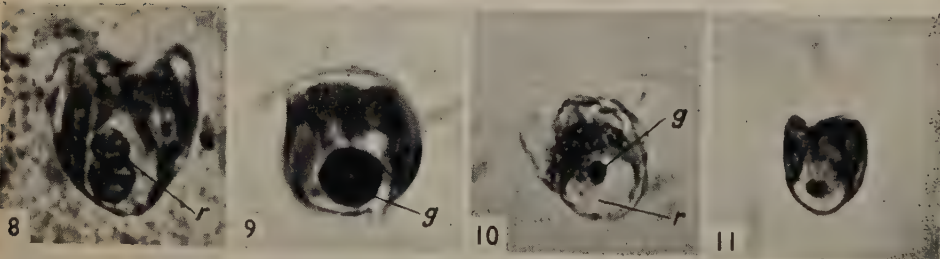


Figure

Apical view of cell looking through partially restricted lumenal at granules inside reservoir ring in center.

Figure

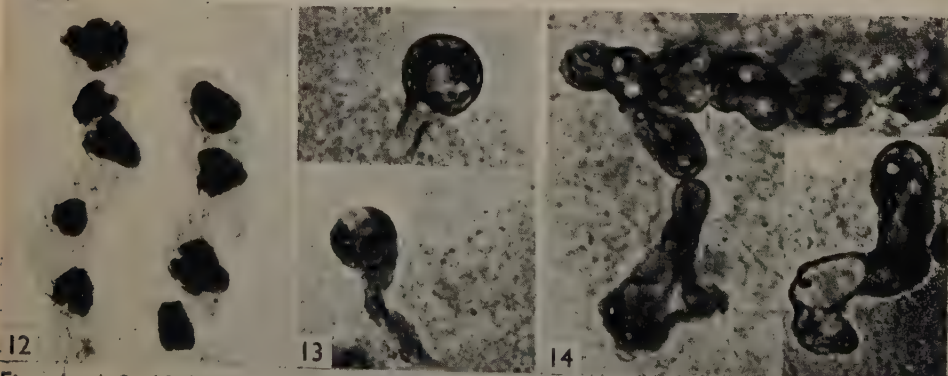
Apical view of fission stage with pyrenoids and canal, partly into two; looking through canal empty reservoir.



Figures 8

Four different an unhealthy cell with material inside the reservoir. Figure 8 placed in Figures 9-11. White have through the canal the canal re-

Fig. 12 |————| 20 μ



Figure

Cells in non-phase inside ginous envelope left cell dividing.

Figure

Cells in non-phase rounded attached by common stalk.

Figure

Non-motile cells aggregated and grow together to give appearance of a fi-

Figures 1-4 — Cells showing anterior lobes either in a vertical position or incurved partly enclosing anterior depression; pyrenoids (p) and reservoir (r) visible.

Figure 5 — Cell with four

reservoir visible.

Figs. 1 - 4, 8 - 10. |————| 20 μ

Figs. 5, 6, 11, 13, 14. |————| 20 μ

side of the body and swim off in the opposite direction. This stage shows a distinct phototactic response.

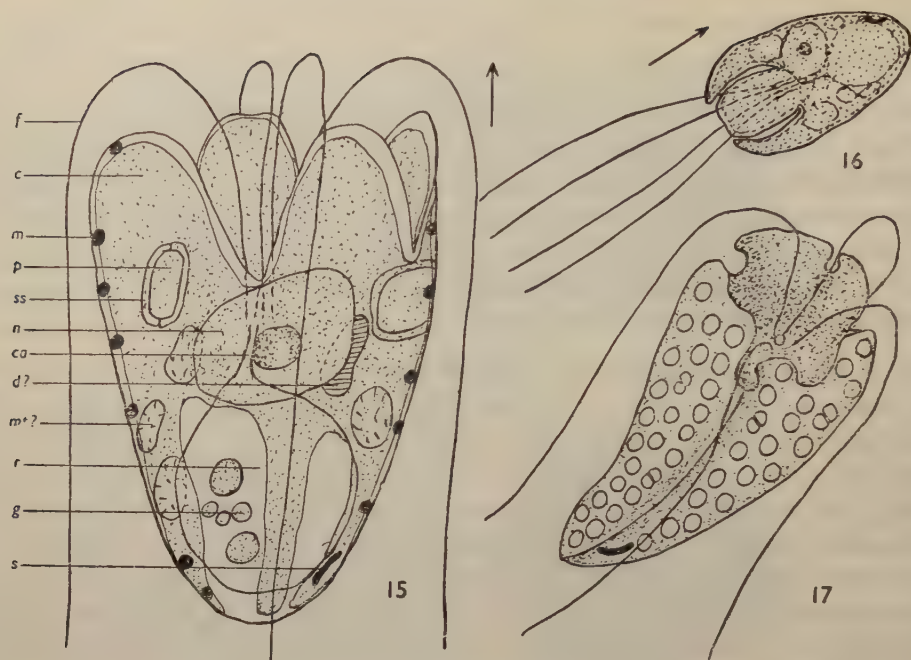
The anterior body lobes, usually making up about one third the length of the cell, can be outwardly or inwardly curved or vertical when the cell is swimming with them either directed forwards or backwards (Figures 1-5, 15-17). In the smaller cells the lobes and longitudinal costae are not so pronounced as in the larger cells and early fission stages. All sized individuals are squarish in apical view (Figure 6) but the larger cells and early fission stages appear to have the four corners cut out to give the shape illustrated in Figure 7.

In an actively growing culture 73% of the cells are from 18 to 24 μ in length while 22% are between 14 and 18 μ . The remaining 5% are usually incipient fission stages and range from 24 to 28 μ in length. It is extremely difficult to keep the natural shape of this motile-stage (Figures 1-4) when fixing it; usually the cell becomes shorter and much broader (Figure 5) and frequently the anterior lobes cannot be discerned. The smaller preserved individuals with two pyrenoids on opposite sides of the body, then appear similar in size, shape and content to the marine species *Pyramichlamys wetsteinii* (Schiller) H. et O. Ettl (1959); the individuals with 4 pyrenoids can also resemble *Pyramimonas cruciata* Conrad et Kufferath and *P. tetralampas* Conrad et Kufferath (1954).

Fission in the motile stage occurs most commonly in the afternoon. Usually four pyrenoids (Figure 7), two nuclei, two reservoirs and canals and two stigmata can be distinguished in incipient fission stages but the new daughter-flagella form only as the cell body divides. Body fission starts at both poles but continues mainly from the flagellar pole so that fission is completed close to the non-flagellar pole. Occasionally, the two new daughter-flagella do not develop until after the daughter-cells have separated, and therefore, individuals with only two flagella, or with two normal length flagella and two short flagella, can be encountered.

After the *Pyramimonas*-stage of *Halosphaera* has reached the peak in growth in culture, the motile cells sink to the bottom of the flask, discarding or absorbing their flagella, and, either secrete a mucilaginous envelope in which they divide (Figure 12), or round off and attach themselves to the glass by a colourless stalk, produced by the posterior end of the cell (Figure 13). These attached forms then elongate and when grouped together appear filamentous (Figure 14). We have not a complete picture of all the stages in the life-history of *Halosphaera viridis* but from additional strains already isolated we hope to obtain further information.

Internally the *Pyramimonas*-stage possesses structures which are certainly of extreme interest from a phylogenetic view-point (Figure 15). The peripheral muciferous organelles (m) or trichocysts, recorded previously for some *Pyramimonas* species (e.g. Chadeaud 1937, 1941) but not present in all species (e.g. absent in *P. grossii*



Pyramimonas stage of *Halosphaera viridis* Schmitz

Figure 15

Individual swimming with flagella and body in the position characteristic for the species when the flagellar insertion is directed forwards during swimming. c, chloroplast; ca, canal opening into reservoir inside body; d, dictyosome?; f, flagellum; g, carotinoid (?) granules in reservoir; m, muciferous organelle or trichocyst; mt, mitochondrion?; n, nucleus; p, pyrenoid; r, reservoir connected to exterior by canal; s, stigma; ss, starch sheath of pyrenoid in two sections. $\times 2500$.

Figure 16

Individual with flagellar insertion directed backwards during swimming with the four flagella trailing. $\times 1250$.

Figure 17

Cell showing the origin of the flagella from the anterior depression, the metaboly of the body and the rows of muciferous organelles in the peripheral body layer. $\times 1250$.

Parke), are clearly visible in the living cells of the *Halosphaera Pyramimonas*-stage. They eject their contents as rods, threads or balloons when treated with vital stains which also stain the organelles *in situ*. The hemispherical shape and arrangement in pairs (Figure 17) of some of these muciferous bodies suggest they may increase in number by division and not arise *de novo*. One kidney-shaped body, possibly a dictyosome, and four ovoid bodies, possibly mitochondria, have been observed and are indicated in Figure 15.

Two or four undoubted pyrenoids (p), surrounded by their starch sheaths, are clearly visible in the translucent living cell (Figures 1-7, 15-16), the starch sheath becoming a purplish blue when treated with iodine. Four parabasal bodies lying in

a similar position in the body to the pyrenoids in the motile stage of *Halosphaera* have been described by Chadeaud (1941) for a species of *Pyramimonas* but we have not detected similar bodies in the *Halosphaera*. Although it is more usual for one basal pyrenoid to be present in members of the genus *Pyramimonas* four pyrenoids have been recorded previously for *P. amyliifera* Conrad (1939), *P. cruciata* Conrad et Kufferath, *P. tetralampas* Conrad et Kufferath.

The last, and undoubtedly the most important, body present in the motile cells of *Halosphaera*, visible with the light microscope, is the large spheroidal basal reservoir (r) with its canal (c) connecting it to the surrounding water (Figures 1–11, 15–16). Following Chen (1950) we have used the word reservoir in preference to gullet or pharynx as we have no evidence that the function of this organ is the intake of solid food. Using the procedure of Parke (Parke, Manton and Clarke 1955) for checking possible phagotrophy in members of the Chrysophyceae, intake of graphite or plant cells into the reservoir was not recorded when the cells were healthy. When, however, a culture of this organism with added graphite and other plant cells was left accidentally overnight in a hot room, in a vessel from which detergent may not have been thoroughly removed, the next day the cells appeared unhealthy and many of them had either graphite (Figures 9–11) or plant cells (Figure 8) inside the reservoir.

This peculiar behaviour suggests that external agents can affect some internal structure, which we have not detected with the light microscope, which controls the opening (Figure 7) and closing (Figure 6) of the canal. When the canal is relaxed (individual unhealthy?) and the cell is swimming with the anterior pole forwards, material could pass quite easily through the canal into the reservoir as the cells swim through the water. It is possible that a structure similar to the sphincter in the canal of some members of the Euglenophyceae may control the opening and closing of the canal in this motile-stage, since according to Chen (1950) particles do not enter the reservoir in members of the Euglenineae. The granules, usually pigmented and possibly of a carotinoid nature, seen frequently in the reservoirs of cells of the *Halosphaera* motile-stage, may be products of metabolism, as are possibly the minute granules found in the large pusule of the dinoflagellate, *Exuviaella mariaelebouriae* (Parke and Ballantine 1957). Individuals of the *Pyramimonas*-stage of *Halosphaera* have been watched under the microscope for as long as the cells remained healthy, but, no contractile vacuoles have been seen, nor has the reservoir been seen to contract or disappear from view, although occasionally, individuals were seen in which the reservoir could not be detected. The reservoir of this motile-stage may possibly be comparable to the gullet described for the cellulose-walled genus *Platymonas* (*Tetraselmis* — see Butcher 1959). In this genus the gullet appears to be, as in the Euglenophyceae, a collecting organ for waste material (H. and O. Ettl 1959), but at present the true function of the reservoir in the *Pyramimonas*-stage of *Halosphaera* is unknown.

The discovery of a reservoir connected to the exterior by a canal in this *Pyramimonas*-stage, which lacks a cellulose wall, is a find of major interest since there has been a great deal of cytomorphological speculation concerning the affinities of the naked genus *Pyramimonas* and the walled genera *Platymonas*, *Prasinocladus* and *Chlorodendron* (Chadefaud 1937, 1941, 1947, 1950; Pavillard 1952; Hollande *et al.* 1954). It has been suggested also (H. and O. Ettl 1959) that if only the genus *Platymonas* lacked a cellulose wall the relationship of the green algae with the Cryptophyceae would be closer than has been admitted so far. We suggest that in isolating this *Pyramimonas*-stage of *Halosphaera* we may have found Ettl's naked "Platymonas". Chadefaud (1937, 1941, 1947, 1950), as early as 1937, suggested that the genus *Pyramimonas* and its allies should form a special group transitional between the Volvocales on the one hand and on the other the assemblage made up of the Euglenophyceae, the Cryptophyceae and their allies. By maintaining this *Pyramimonas*-stage of *Halosphaera* and similar forms in culture it is hoped that future study may elucidate the life-histories and the phylogenetic relationships of these very puzzling organisms.

ACKNOWLEDGMENT

We wish to thank Dr. T. Christensen for translating the English diagnosis into Latin.

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BOSTRYCHIA FLAGELLIFERA POST IN JAPAN

A SYNOPTIC STUDY

ERIKA POST

Kiel

ABSTRACT

The Australo-New Zealandian *Bostrychia flagellifera* is also found in Japan. Morphogenesis, ramification, pericentrals cortex, haptera and fructification of the species are dealt with. The synecology, geographical and ecological distribution are discussed and illustrated by a world distribution map, five site plans and a station table.

INTRODUCTION

The hitherto unknown fact that the Australo-New Zealandian *Bostrychia flagellifera* occurs also in Japan, i.e., north of the tropic of cancer, calls for a study on this sister species of *Bostrychia scorpioides* which is sufficiently well known at the European shores of the Atlantic. The European *B. scorpioides* is also found in the Australo-New Zealandian area, further in America and in South Africa. Prof. Rayss will no doubt confirm the Red Sea record* of the species, in view of its marked preference for halophytic substrata, such as mangroves and Chenopodiaceae.

B. flagellifera grows in Australia on mangroves at river estuaries, whereas in New Zealand and Japan it inhabits lava-covered rock, a substrate also marked by reduced salinity. These two stations lie 38 latitudinal degrees apart.

Bostrychia flagellifera Post

- 1936 Post "System. pflzgeogr. Notiz.", Rev. algol. **9**, 34;
1938 Post "Weitere Daten Verbr. Bostr. II", Hedwigia **78**, 209, 210;
1939 Post "Weitere Daten Verbr. Bostr. III", Arch. Protistke: **93**, 25, 13, 37;
1955 Post "Weitere Daten Verbr. Bostr. IV", Arch. Protistkde: **100**, 361;
1955 Post "Weitere Daten Verbr. Bostr. V", Ber. dtsch. bot. Ges. **68**, 209.
— sub *Bostrychia* "*Wardii*";
1897 J. Agardh "Anal. algol. Cont. IV", Act. reg. Soc. Phys. Lund **8**, 77;
1903 De Toni "Sylloge alg." IV, **3**, 1159;
1909 Lucas "Rev. List. Austr.", Proc. Linn. Soc. N. S. Wales **34**, 47;
1910 Mazza "Sagg. Alg. Ocean.", Nuov. Not. **21**, 94;
1924 De Toni "Sylloge alg. Addit." VI, 434;
Exsicc. J. Agardh "Algae Muellerianae" (no Nr.; sub *Bostrychia* "*Wardii*").

Type locality: Sydney, Paramatta River.

* A. F. W. Schimper 1890, on sticks (E. P.: *Avicennia* ?) with *Leveillea*.

Received April 15, 1960.

Bostrychia flagellifera is flagellifulcrate, corticated, possesses in longitudinal direction two pericetrals on the central cell, is not differentiated in definitive and indefinite branches; ultimate branchlets monosiphonous; individuals 1.5 to 3.5 cm high, averaging 2.5 cm; growing mostly in dense tufts intermingled with its associates.

Habitually it resembles *Bostrychia scorpioides* which is also found in Australia and New Zealand but not in the same habitats. From the morphogenetical viewpoint, *B. flagellifera* is to be considered the neotenic 'form' of *B. scorpioides*. The formation of the pericentrals does not take place in the ultimate branchlets (Agardh 1897: "ramulisque plurimis elongatis monosiphoneis"). At the same time this is the only essential distinguishing feature between the two species, parallel to the situation between *Bostrychia radicans* [*Bostrychia moritziana* and *Bostrychia binderi*] *Bostrychia tenella*. Owing to the lack of differentiation into long shoots and short shoots, *B. flagellifera* looks more or less triangular in outline, described by Mazza somewhat less pronounced as "semicircolare-lobato". His "con ambitu oblungo" refers, however, only to a single branch of the plant ("nelle primarie divisioni"). Therefore Mazza's feature 'quasi piumati' should not be attributed to *B. flagellifera*. The tips of *B. flagellifera* are not inrolled, in contrast to those of *B. scorpioides*; nor does the former species display any lateral curvatures, though adult ramuli may often be typically sickle-shaped, similarly to the ultimate branchlets of *B. radicans*. Branches of *B. flagellifera* are arranged distichously: "alterne et subdistiche ramosa" (Agardh 1897). As seen on Plate I, Figure 1 the monosiphonous branchlets of the last-and pre-last order in adult individuals of *B. flagellifera* are more or less fastigiate (Agardh: "corymbos laterales"), similarly to *B. tenella*. Only in rare instances — also in von Mueller's material — were proliferating long colourless ramules observed, indicating unfavourable conditions just as in other *Bostrychia* species (both mono- and polysiphonous:*). In *B. flagellifera* there occur occasionally depauperate shoots on otherwise normally branched individuals though not very typically developed. Yet, I never observed "pinellae secundatae" shifted dorsally to the upper side of the rhachis, as they do occur in *B. tenella*, *B. binderi* and *B. scorpioides*. However, in the Japanese material of *B. flagellifera* the monopodial main axis is sometimes tipped over dorsiventrally. Branches of the first order in *B. flagellifera* are more or less bent in zigzag (flexuous). The rhachis in adult individuals is straight (Plates I and II); in the apical region (cf. Figure 1) it is more or less (pseudo-) dichotomous as in all *Bostrychia* species. The ontogenetically youngest stage is monopodial, the following "flexuous" stage is either maintained throughout or constitutes merely a transitional stage to the secondarily re-straightened main axis. Adventitious (endogenous) branching of a normal as well as of a regenerating kind has been observed in *B. flagellifera*. In von Mueller's Paramatta material of the species I observed formation of adventitious branches from rather old strongly corticated rhachides. Furthermore, I noticed in the same material an apical, central, still unicellular regeneration from a rhachis stump. In the New Zealand material I

* This term refers to branches of the last order.

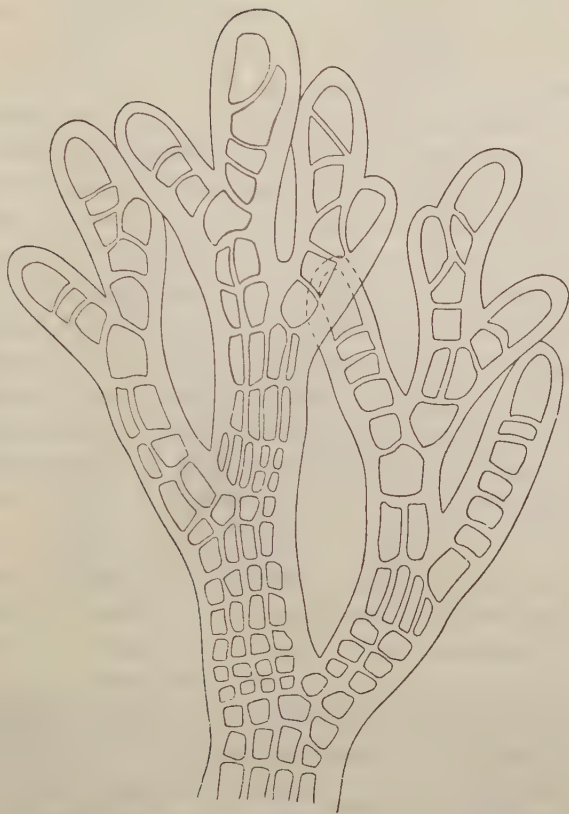


Figure 1

Bostrychia flagellifera (Paramatta River mouth; Sydney). Growing tip with 12 apical cells, more or less tending to pseudodichotomy (oblique placing of walls). $\times 400$.

und regenerating cuttings ("Stecklingsregeneration") with two monosiphous regenerates at the basal part. The lesions—the cause of the regeneration—were not only accidental but in most cases were probably due to animal browsing*, though the morphological situation in cylindrical *Bostrychias* is not so obvious as in the plane *Caloglossas*.

In transversal direction the rhachis of *B. flagellifera* develops 6 to 8 pericentrals (Agardh: 6 pericentrals; Mazza: 6–8 pericentrals) and proceeds thereon to formation of cortex: 'extus corticalibus cellulis paucis seriatis cinctis' (Agardh), designated by Mazza superfluously 'cellule sussidiare' and 'cellule inguainati' respectively. As in most corticated *Bostrychia* species the cortication of *B. flagellifera* increases towards the apical region, so that the successive formation of polysiphous and monosiphonous segments is obvious: "indie corticata" (Mazza).

* See p. 109.

B. flagellifera like all flagellifulcrate *Bostrychia* species, has typical emergence haptera growing ventrally out of the branching points; they form a more or less long process looking exactly like a flagellum (Plate I, Figure 1), as indicated by the species name. The three haptera visible in Plate I, Figure 1, have not yet 'seized' and consist therefore only of the congenital zone. The terminal zone of not growing together hyphen filaments (rhizoids) is lacking here. In von Mueller's Paramatta material of the species I twice observed a double hapteron in opposite position, occasionally also in May's Georges River—and in Carnahan's New Zealand material. Thus such 'latent' haptera are not necessarily connected with "fluitans" occurrence. In the respective rhachis parts the cortex cells grow to a vigorous attaching organ not only ventrally—as is normally the case—but also dorsally (Plate I, Figure 2). This observation agrees well with Falkenberg's (1901) analogous findings for *B. scorpioides* (as *Bostrychia harveyi*). He states for this sister species of *B. flagellifera* equally two opposite haptera in young stage, yet emphasizes the fact that—always only one of them fully develops, in accordance with the normal hapteral behaviour in *Bostrychia* species.

Von Mueller's *Bostrychia flagellifera* material which circulated until recently as *Bostrychia wardii* (now *Bostrychia moritziana*) on the strength of Agardh's authority (1897): "quae cum Harveyana planta optime convenientur", has with the latter only the monosiphonous ramuli in common, but neither cortication nor the type of haptera. *Bostrychia moritziana* from the Friendly Islands (*B. wardii*) is ramifulcrate and ecorticate (Incidentally, the respective material is to some extent strongly decayed). Already Lucas (1909) doubts the identity of the Paramattian *B. "wardii"* with Agardh's *B. wardii* (ex Harvey): "doubtfully identical with the Tongan form"; likewise Mezsa's "la piante è forse ancora un pocco negletta sia pel fatto di confondersi con le congeneri", is to be understood in a similar way, though neither he nor Lucas drew the logical conclusions.

As regards fructification, Mazza (1910, p. 404) observed in *Bostrychia flagellifera* stichidia with "tetrasporangl 4-verticillati". I found in the same—von Mueller's Sydney material—stichidial whorls of 4 to 7 tetrasporangia; 6-counting fertile whorls are to be inferred from Plate II, Figure 1. Dorsiventral stichidia, monosiphonous petiolated stichidia—though often relatively strongly overtipped—and serial stichidia have no (yet) been observed by the author in *B. flagellifera*. However, in von Mueller's material frequently occur stichidia vegetatively grown through and that in the extremest manner: the rhachis may even ramify pseudodichotomously above those stichidia. Thus, the vegetative growth of the plant is not even retarded by the onset of fertility so that such individuals of *B. flagellifera* look somewhat monstrous (cf. Plate II, Figure 2). I also found in Valerie May's mangrove material of the species from Georges River two grown through stichidia side by side with normal stichidia.

Tetrasporophytes of *Bostrychia flagellifera* are recorded up till now from the nor-



Figure 1



Figure 2

Plate I

Figure 1. *Bostrychia flagellifera*, Sydney. Habitus of the "fluitans" form. With three "latent" relatively long emergence haptera. $\times 20$. Figure 2. *Bostrychia flagellifera*, Sydney. Rhachis with double hapteron. Exceptional behaviour: flagelliformous emergence haptera not only ventrally developed as normally, but on the dorsal side too; possibly owing to orientation change in the flowing of the river. $\times 60$.



Figure 1



Figure 2

Plate II

Figure 1. *Bostrychia flagellifera*, Sydney. Tip of a tetrasporiferous plant. Right in picture two fully developed stichidia. The cortication is easily recognized. $\times 40$. Figure 2. *Bostrychia flagellifera*, Sydney. Vegetatively grown through, emptied stichidium (exceptional case). Already closely above it ramification carries on. $\times 25$.

thern hemisphere for the month of June (Japan*) and from the southern hemisphere for July (Georges River) and September (Moreton Bay). The two latter dates would correspond to January and March of the northern station. Antheridia are hitherto not known for *B. flagellifera*; cystocarps have been observed by Mazza (1910, p.404) in von Mueller's Sydney material: "cistocarpi terminati in un rametto polisifonio".

ECOLOGICAL DISTRIBUTION

Bostrychia flagellifera is not only absent from fresh water; the purely marine occurrence is lacking too. *B. flagellifera* is characteristic of brackish water: "è inoltre d'ascriversi fra quelle che risalgono eventualmente i fiumi del litorale orientale Australiano, almeno fin dove arriva il flusso marino" (Mazza). Three—probably four—of the six known stations of the species are epiphytic occurrences on mangroves (*Avicennia*). The remaining two are not arboricolous, but rupi-respectively terricolous: on lava soil or on rocks covered with sedimentated lava soil.

As Professor Tanaka's article (1953)* on the algae of Kagoshima Bay is written in Japanese, I briefly quote here (according to Mr. Michiyasu Mori's kindly made translation) the ecological indications interesting for *Bostrychia (flagellifera)*. Sono-yama Ike, a pond of about 200 meters in circumference and 3–4 meters deep was formed by confluence of lava at the foot of the 75 meters high Sonoyama hill (west side) northeast of Sakurazima Volcano at Kagoshima bay (Figure 2). The pond's edge is 10 meters distant from the sea, and is about one meter above sea level. It contains *Mugil cephalus*** and *Anguilla japonica***. Its bottom is covered with *Ulva pertusa*** and *Enteromorpha***. At high tide sea water can pass into Sonoyama Ike through cleavages in the lower part of the lava. That is why the salinity of the pond is slight. Its water temperature is low: 16.4°C as compared to 28.3°C in the sea. The pond water is extraordinarily pure. Professor Tanaka found *Bostrychia* (E.P.: *flagellifera*) on the northern and eastern banks of Sonoyama Pond in mats of about one square meter on lava rocks and even on the banks themselves above low tide. I found the *Bostrychia* covered with enormous quantities of solitary diatoms and intermingled with few *Lophosiphonia* and *Cyanophyceae* tufts. I am sure that *B. flagellifera* grows in this locality likewise on the lower parts of *Aster tripolium* and *Limonium japonicum*, stated by Professor Neito: "in fine community" on the sandy southern and western banks of Sonoyama Ike.

Next I wish to refer to the New Zealand station of *Bostrychia flagellifera* in the Scoria*** Flat Inlet on Rangitoto Island as it has some features in common with

* Contrary to Professor Tanaka's indication "According to the occasional survey of the writer the fruit bodies (E. P.: of *Bostrychia*) have never been observed on the thallus" (Tanaka T. "A short report on the seaweeds of Kagoshima Bay". Bull. Japanese Society of Phycology vol.1, No.1, pp. 33, 34, 1953), I was able to state repeatedly tetraspores in his material, kindly put at my disposal.

** For this argues too the occurrence of the Mediterranean fish *Mugil cephalus* (beside *Anguilla japonica*), known to prefer brackish water, further *Ulva pertusa* and *Enteromorpha* at the bottom of the pond.

*** "Scoria" is rough vesicular cinderlike lava, generally dark coloured.

the Japanese habitat of the species. As already mentioned, the alga grows in both—geographically widely separated—stations on lava soil at reduced salinity. Mr. Carnahan, the collector of the New Zealand material, informed me in his letter of 8.V.54: "Rangitoto Island is a heap of broken volcanic rocks. The lava rock has a rough surface which collects sediment. The shores of Scoria* Flat Inlet are a



Figure 2

Outline of that characteristic small peninsula opposite Kagoshima Harbour with Sonoyama Pond at its N. E. corner. x -station of *Bostrychia flagellifera* on the north-eastern bank of Sonoyama Ike.

mosaic of rock and mud (E.P.: The *Bostrychietum* material from here is very muddy). The rock community of *Bostrychia*/*Caloglossa*/*Catenella* (E.P.: to which *B. flagellifera* belongs) is found where there is some sediment. There is no surface water on Rangitoto. However, there may be a little brackish influence in the inner part of Scoria Flat Inlet: water coming from under a lava flow at the head of the inlet was found to have a salinity that was 90 % of the salinity of the sea off the south coast of Rangitoto Island". As Mr. Carnahan's photo fig. 4, p. 39 in "Pacific Science" vol. 6, 1952 shows, there are—if one may use this expression—in the inner part of Scoria Flat Inlet three "facies" strongly crowded together: I found in the *Bostrychietum* material of the rock community also *Avicennia* "sticks" (pneumatophores) overgrown with the *Bostrychietum*. "There were mangroves within two or three feet of where I collected the material in question" (Carnahan by letter 21.IV.55). And I presume that *Bostrychia flagellifera* is growing here also on *Salicornia*, as the third "facies". "I... noticed that a *Bostrychia*/*Cataglossa*/*Catenella* community similar to that the on rocks was growing on the stems of *Salicornia* in the inner part of Scoria Flat Inlet" (Carnahan by letter 20.I.55). In the *Bostrychietum* tufts of the rock community of

* "Scoria" is rough vesicular cinderlike lava, generally dark coloured.

Part of South coast of Rangitoto Island

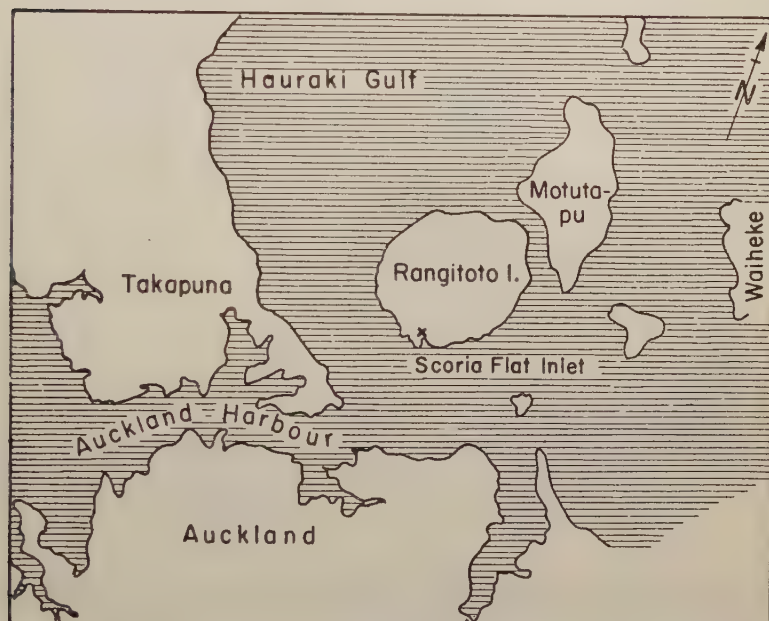


Figure 3

Outline of Auckland region (eastern shore of northern New Zealand). Hauraki gulf with Rangitoto Island. Above: south coast of Rangitoto Island. Magnified 1×10 . x-station of *Bostrychia flagellifera* in "inner part of Scoria Flat Inlet".

the inner Scoria Flat Inlet *B. flagellifera* is nearly as abundant as *Catenella nipae* which is of about the same size. Also var. *hookeri* of *Caloglossa leprieurii* grows plentifully in the community of this "sheltered place", producing 4 mm long trunklets ("Stämmchen"). In reply to my inquiry, Mr. Carnahan attributes browsing injuries* of its leaflets to the snail *Ophicardelus costellaris* (Ellobiidae). The much slenderer *Bostrychia moritziana* keeps on fastening with its little branch haptera on *Caloglossa*, *Catenella* and equally among the stout *Bostrychia flagellifera*. More in the background

*Cf. p. 103.

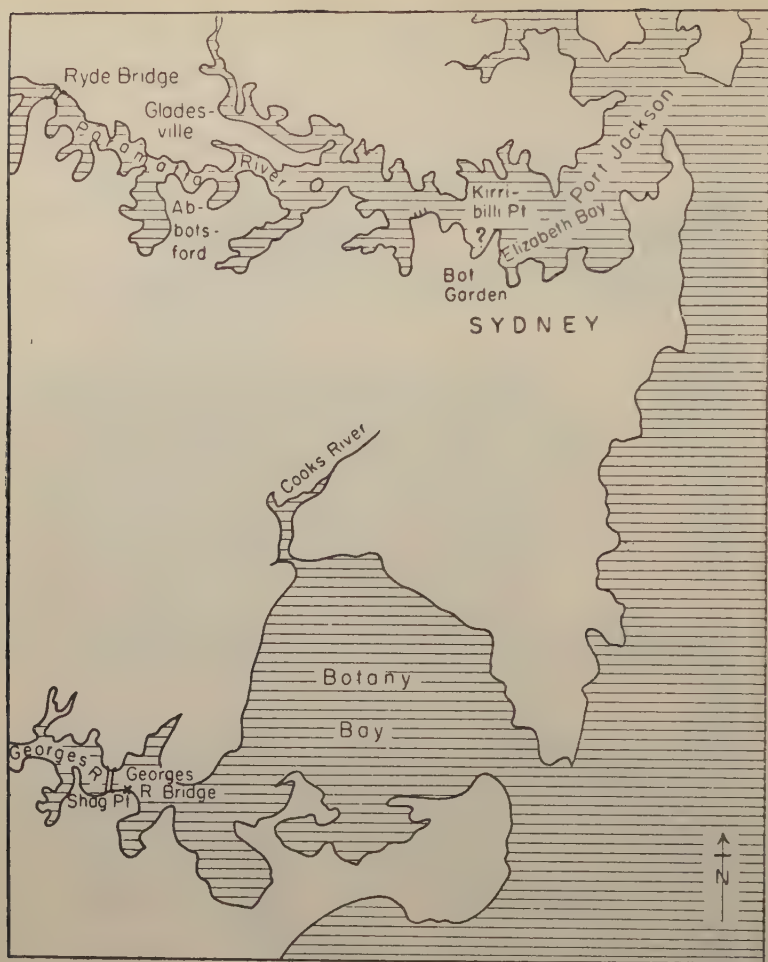


Figure 4

Outline of Sydney region (in the wider sense: Port Jackson to south of Botany Bay). Von Mueller's station of *Bostrychia flagellifera* at the Paramatta River mouth not marked. ("?" Botanical Garden Sydney, on the Paramatta River). x-station "between Georges River Bridge and Shag Point in the Georges River estuary". All other names marked on map refer to *Bostrychietum* stations.

in the *Bostrychietum* tufts of the Scoria Flat rock community are the likewise inconspicuous *Bostrychia mixta* and *Bostrychia tenuis*.

In its four known Australian stations *Bostrychia flagellifera* grows—as said before—on mangroves (*Avicennia*)*, in estuaries more or less distant from the

* The same substratum may be assumed too for von Mueller's type material of the species from the Paramatta River (mouth). It is not indicated on the label. In a number of instances I found the *Bostrychietum* tufts from here still attached to "sticks". Analogous "sticks" in corresponding New Zealand material have been identified for me by Mr. Carnahan unhesitatingly as belonging to *Avicennia*. Ferdinand von Mueller (made a baron by the king of Württemberg at a later time) collected *Bostrychia flagellifera* for the first time in the region of Sydney (type locality) about a hundred years ago.

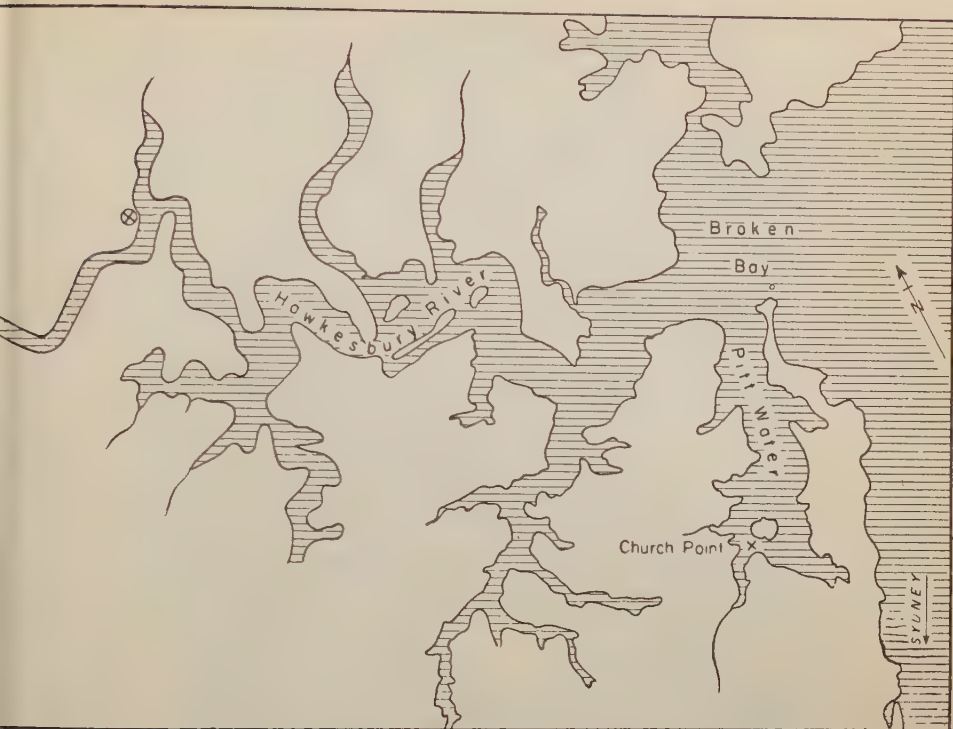


Figure 5

Outline of Hawkesbury River region (20 miles north of Sydney) ×-station of *Bostrychia flagellifera* in Pitt Water, an arm of the Hawkesbury River "about 1/4 mile from Church point". ⊗ Lucas's *Bostrychietum* station (*B. moritziana*, *Caloglossa leprieurii*) "20 miles from the mouth (of the Hawkesbury River), still a broad deep river, well in tidal influence".

river mouth. Miss Valerie May collected *B. flagellifera*—associated with *B. moritziana*, *B. tenuis*, *Caloglossa leprieurii* and *Catenella nipae*—in the Georges River estuary as well as a week later in the Hawkesbury River estuary "abundantly on the dead stumps, tree bases and pneumatophores of both *Avicennia officinalis* and *Legiceras major*. They (E.P.: members of the *Bostrychietum*) were exposed most of the time between tides and were most prevalent near the salt water channels which remained at low tide" (V. May; comm. R. H. Anderson by letter 22.VIII.38). The *Bostrychietum* material from the Georges River estuary between Georges River bridge and Shag Point is very clean, whilst that from the Hawkesbury River estuary from the Pitt Water, about a quarter mile from Church Point, proved to be very muddy. According to Dakin *et al.* (1948*) the Pitt water, the long, seven mile arm of the Hawkesbury estuary, contains much fine mud suspended in it; its water is probably less saline in wet weather.

* Dakin, Bennet & Pope: "Study of certain aspects of the ecology of the intertidal zone of the New South Wales coasts". Australian J. of Sci. Research, Ser. B, Vol. 1, No. 2.

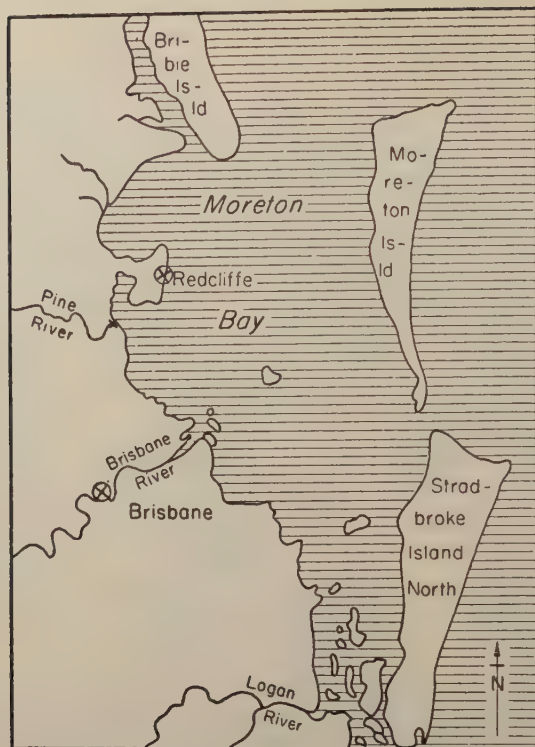


Figure 6

Outline of Moreton Bay (Brisbane). ×-station of *Bostrychia flagellifera* on the Pine River mouth. ⊗ Cribb's *Bostrychietum* stations near Redcliffe "north of Pine River mouth": on mangroves (*B. moritziana*, *B. tenella*, *Caloglossa leprieurii*) resp. "in crevices on wooden retaining wall in upper littoral" (*B. tenella*, *B. radicans*). ⊙ Cribb's *Bostrychia kelanedsis* station "on retaining wall mid littoral", on the Brisbane River/Brisbane, intermingled with *Caloglossa leprieurii*.

Mr. Cribb wrote to me: "My *Bostrychia* collection No.23.15 was made from the base of the trunk and from the pneumatophores of *Avicennia marina* var. *resinifera* growing on muddy situations on the shores of Moreton Bay. The locality is sometime subjected to considerable reduction in salinity following late summer floods in the rivers entering Moreton Bay" (6.V.60). In Cribb's *Bostrychietum* material from the Pine River mouth northwest of Brisbane River (Moreton Bay) the much smaller and more slender *B. moritziana* keeps on creeping on the essentially larger and coarser *B. flagellifera* as is the case in the New Zealand station of the *Bostrychietum* (see above).

Syncologically, as may be seen from the "Associates" column of Table I, the following *Bostrychietum* species are the obligate "consociales" of *Bostrychia flagellifera*:



Figure 7

World distribution with the hitherto known six stations of *Bostrychia flagellifera*. 1. Sonoyama Island—Kagoshima Bay. 2. Pine River mouth—Moreton Bay (Brisbane). 3. Pitt Water—Hawkesbury River. 4. Paramatta River mouth (Sydney). 5. Shag Point—Georges River. 6. Scoria Flat Inlet—SW. Rangitoto (Auckland).

B. moritziana (5)

B. tenuis (4)

B. mixta (2)

Caloglossa leprieurii (5)

Caloglossa bombayensis (1)

Catenella nipae (4)

The figures in brackets indicating the number of stations of the respective *Bostrychia* species in which they are found together with *B. flagellifera*. *Bostrychia moritziana* and *Caloglossa leprieurii* occupy the sociological optimum for *B. flagellifera*, followed by *Bostrychia tenuis* and *Catenella nipae*, growing together with *B. flagellifera* in four of the six known stations. Rarely only is *B. flagellifera* associated with

Table of the hitherto known stations of *Bostrychia* flagellifera

Fructification	Station	River	Distance from river mouth		Collector	Date of collection	Substrate	Sym-bol	Associates			Sym-bol
			km	miles					Obligate		Facultative	
⊕	N & E bank of <i>Sonoyama Ike (Pond)</i> NE of Sakurazima Volcano-inner Kagoshima Bay/S. Kiusiu, Japan	Pond; low in salt. Seawater can pass through lava cleavages at high tide	10	11	T. TANAKA	June 1952	lava rock surface and muddy banks	ru te	—	—	—	2 Δ B 1
⊕	Mouth of Pine River (right bank; N. of Brisbane)-Moreton Bay/Qd., Australia	Pine River	—	—	A. B. CRUMB no. 23.15	1st Sept. 1949	<i>Avicennia</i> pneumatophores.	arb	<i>B. tenuis</i> <i>B. moritziana</i>	<i>C. leptocaulis</i>	—	Δ B 3
	About ½ mile from <i>Church Point-Pitt Water/Hawkesbury River</i> , 20 miles N. of Sydney, N.S.W., Australia	Hawkesbury River	9.6	6	VALERIE MAY-JONES	7th August 1938	<i>Avicennia</i> and <i>Aegiceras</i>	arb	<i>B. moritziana</i> <i>B. tenuis</i>	<i>C. leptocaulis</i> <i>C. nipae</i>	<i>Lophosiphonia</i> filamentous <i>Cyanophyceae</i>	2 Δ B 3
⊕; ⊖	Paramatta River mouth-Sydney/N.S.W., Australia	Paramatta River	8.5	5.3	F. VON MUELLER (1852)	"sticks" (<i>Avicennia</i> ?)	? arb	<i>B. moritziana</i>	<i>C. leptocaulis</i> <i>C. bona-yensis</i>	<i>C. nipae</i>	<i>Caulacanthus</i> <i>Lophosiphonia</i> <i>Rhizoclonium</i>	3 Δ B 2
⊕	Between <i>Georges River</i> Bridge & <i>Shag Point-Georges River</i> estuary/S. of Sydney, N.S.W., Australia	Georges River	12.5	7.5	VALERIE MAY-JONES	31st July 1938	<i>Avicennia</i> and <i>Aegiceras</i>	arb	<i>B. moritziana</i> <i>B. tenuis</i> <i>B. mixta</i>	<i>C. leptocaulis</i> <i>C. nipae</i>	<i>Rhizoclonium</i>	Δ 1
—	Inner part of <i>Scottia Flat Inlet-S. Rangitoto Island/Hauraki Gulf</i> (Auckland), Eastern coast N. New Zealand.	water coming from under a lava flow	—	—	J. A. CARAHAN	16th Jan. 1955	muddy lava rocks	ru (te)	<i>B. moritziana</i> <i>B. tenuis</i> <i>B. mixta</i>	<i>C. leptocaulis</i> <i>C. nipae</i>	<i>Rhizoclonium</i> <i>Chaetomorpha</i>	2 Δ B 4

LEGEND:

Fructification symbols: ⊕ = with tetrastrophangia; ⊖ = with cystocarpus; m = marine; br = in brackish water. For the distance value of the Von Mueller's Sydney station of *Bostrychia flagellifera* has been taken hypothetically the Botanical Garden of Sydney, situated at the Paramatta River ("?"). — According to Valerie May-Jones (1938) the Church Point station of *B. flagellifera* in the Hawkesbury River estuary — "on right hand side of river, facing mouth" — "is 6 miles distant from Broken Bay entrance and the *B. flagellifera* station in the Georges River estuary" — "on right hand side of river, facing mouth" — "7 to 8 miles from Botany Bay entrance" (comm. R. H. Anderson).

Facies symbols: ru = rupicolous (on rocks, stones); te = terricolous (on soil as river bank, etc.); arb = arboricolous (on trees: mangroves, but also *Pinus*, Leguminosae, etc.). — As symbol for the *Bostrychieum* the triangle has been used: its three sides refer to the obligate *Bostrychieum* associates. *Bostrychia* (B) is represented by the base, *Caloglossa* (Cg) by the left side and *Caenella* (Cn) by the right side. The figure following genus symbol indicates the number of species belonging to the particular genus represented in the community at the respective station. Hereby, *Bostrychia flagellifera* as relation form is included in that B-figure, so added to the *Bostrychia*-associates. The figure within the triangle means the number of the facultative associates of the *Bostrychieum* at the station in question.

B. mixta and *Caloglossa bombayensis*. Of the facultative associates of *Bostrychia flagellifera* the following are to be mentioned: filamentous Cyanophyceae, *Chaetomorpha*, *Rhizoclonium Caulacanthus* and *Lophosiphonia*, the last one being indicated also by Mazza: di giovani "Polysiphonia" con le quali si associa". Agardh, incidentally, identified the *Caulacanthus* in Baron von Mueller's Paramatta *Bostrychietum* material as "Bostrychia" spec. (Herb. div.) He definitely did not mean by this the occasionally intermingled there *Bostrychia flagellifera*. I did already refer to *B. flagellifera* being strongly overgrown with diatoms in the Sonoyama Pond station.

GEOGRAPHICAL DISTRIBUTION

As mentioned above, *Bostrychia flagellifera* is new to Japan, where it occurs on South Kiushiu at Kagoshima Bay.* This Japanese station of the species forms at the same time the northern boundary of its geographical distribution: at 31°35' northern latitude. According to the hitherto known findings the main part of the area of *B. flagellifera* lies in the southern hemisphere (see Figure 7), reaching of its southern boundary with the New Zealand station of the species in the region of Auckland at 36°48' southern latitude. The most northern occurrence of the (southern) main area of *Bostrychia flagellifera* is near Brisbane in the Moreton Bay at 27° southern latitude (Pine River mouth).

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* But not at Makurazaki, as Tanaka (1953) indicates in his article on p. 34, at any case not according to the hitherto knowledge. The *Bostrychietum* at Makurazaki is composed of *B. moritziana*, *B. mixta*, *B. hamana-tokidai*, *B. binderi*, *B. tenella*, besides *Caloglossa ogasawaraensis* and *C. leprieurii*. Equally, the *Bostrychia* from Sonoyama has not yet been stated either from Okinawa or from Kuchino nagarabe or from Miyako City (nondum vidi), as Tanaka (1953, p. 34) indicates likewise. The *Bostrychietum* list for Okinawa includes up till now: a) Daikumata: *Bostrychia tenuis* f. *simpliciuscula*. (= *B. andoi*); b) south of Motobemura: *B. moritziana*, *B. tangatensis*, besides *Caloglossa ogasawaraensis* and *Catenella impudica*.—At Nichinoura on Kuchino-Nagarabe Island (leg. T. Tanaka 23.VII.49) *Bostrychia hamana-tokidai* grows intermingled with *B. tenella*. I was able to see this *Bostrychietum* material too through the kindness of Professor Tanaka.

PROJET DE CLASSIFICATION DES DIFFERENTS NIVEAUX DU SYSTEME LITTORAL SUR LES COTES ATLANTIQUES

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Depuis qu'en 1820, C. M. d'Orbigny ait remarqué, le premier, "les zones ou bandes qu'habite chaque espèce de plante marine sous les eaux de la mer", de nombreuses tentatives de classification des niveaux du système littoral ont été proposées par de nombreux chercheurs afin d'apporter à la fois un ordre et une terminologie qui soient généralement admis. Citons, par ordre chronologique, parmi les auteurs qui ont le plus fait progresser cette question: C. M. d'Orbigny (1820), Audouin et Milne-Edwards (1832), J. Agardh (1836), Orsted (1847), Forbes et Goldwin-Austern (1859), Nylander (1861), Vaillant (1870), Kjellmann (1877), Reinke (1889), Gran (1896), Pruvot (1897), Roseninge (1898), Svedelius (1901), P. de Beauchamp (1914), Dollfus (1914), Sernander (1917), Kylin (1918), Joubin (1919), du Rietz (1925), Sjöstedt (1928), Fischer-Piette (1929), Gilsen (1930), Davy de Virville (1930), des Abbayes (1932), Levring (1935), Feldmann (1937), Bennet et Pope (1953), Lund (1954), Pérès (1956), Ercegovic (1957, Pérès et Molinier (1957) et beaucoup d'autres, car la plupart des chercheurs qui se sont intéressés à la Bionomie marine ont, au moins indirectement, traité cette question (La date indiquée ici entre parenthèse est celle du *premier* travail publié sur cette question). Ce problème a donc été déjà très étudié sans qu'on ait abouti, semble-t-il, à une solution satisfaisante, car il est très difficile et pose comme l'a fait remarquer avec raison le Pr. Feldmann, des problèmes à la fois méthodologiques, terminologiques et biologiques.

Aussi, faut-il être reconnaissant au Pr. Pérès d'avoir tenté de les résoudre au cours de deux réunions successives de la Commission internationale pour l'exploration scientifique de la mer Méditerranée qui se sont tenues à Gênes, en 1957; puis à Monaco en 1958.

Il n'est sans doute pas inutile de rappeler d'abord que ces tentatives de classification ont été établies: les unes, en se basant uniquement sur les variations des facteurs physiques dans la région de balancement des marées dite *intercotidale* (terme qu'il nous paraît utile de conserver); les autres, au contraire, en tenant compte de la succession des organismes sur le littoral; enfin, le plus souvent, en combinant, comme il nous apparaît nécessaire de le faire, ces deux procédés de classement. Car, à notre avis, il est impossible de négliger, pour l'établissement de ces classifications, l'ordre de succession des organismes sur la côte qui est une réalité tangible, exempte, dans une large mesure, de toute interprétation personnelle et, par surcroît, d'observation

très facile. Précisons bien toutefois que nous ne occuperons uniquement ici que de la région intercotidale et des diverses ceintures d'Algues telles qu'on les observe sur les côtes atlantiques boréales (à l'exclusion des ceintures d'animaux que les zoologistes pourront superposer à celles-ci pour compléter utilement le tableau).

Avant toute chose, il convient de définir les termes que nous utiliserons, en indiquant aussi au passage ceux qui nous paraissent devoir être rejetés.

Nous pensons, d'abord, qu'il faut employer le terme *système*, avec la définition donnée au Colloque de Dinard en 1957: un *système* est constitué par un ensemble d'étages présentant des caractères écologiques communs. Nous adapterons, pour l'étage, la définition proposée par Drach, puis par Feldmann, mais en la simplifiant le plus possible pour clarifier autant que faire se peut une question difficile. L'*étage* peut donc être défini comme l'espace vertical du domaine benthique où les conditions écologiques, fonction de sa situation par rapport au niveau de la mer, sont suffisamment stables, pour qu'une ceinture de végétation (ou d'animaux) s'y développe constamment. L'étage peut, pour la commodité, être partagé utilement en sous-étages. Mais nous rejetons le terme d'*horizon*, inutile et souvent inexact, même s'il est pris au sens large ou figuré. De même nous rejetons définitivement le terme de *zone* que nous regrettons d'avoir, nous-même, trop longtemps utilisé pour le remplacer par celui de *ceinture* pour désigner les groupements superposés caractérisés par une espèce dominante d'Algues ou de Lichens que l'on observe généralement, surtout sur les substratums rocheux, à un niveau déterminé qui est principalement fonction de la marée au point considéré. Ces ceintures sont de deux sortes: elles sont dites *constantes* si elles se trouvent généralement partout, par exemple les ceintures de Fucacées; et *sporadiques*, si elles ne s'observent que dans des conditions écologiques particulières, par exemple les ceintures de *Lichina confinis* ou de *L. pygmaea*. Ayant ainsi défini les termes que nous utiliserons, nous proposons, combinant à la fois la classification du Pr. Feldmann et celle du Pr. Pérès, d'adopter la suivante:

Un *système littoral* comprenant tous les étages depuis la limite inférieure de la végétation terrestre jusqu'à la limite inférieure de la végétation marine. Il est supérieur au *système profond* dont nous avons dit que nous ne occuperons pas ici. Ce système littoral est partagé en trois étages: un *étage supralittoral* s'étendant de la limite supérieure de la végétation jusqu'à niveau inférieur des pleines-mers de vive-eau: un *étage littoral* caractérisé par des alternatives quotidiennes d'émersion et d'immersion dues à la marée; et un *étage infralittoral* s'étendant du niveau moyen des basses-mers de vive-eau jusqu'à la limite extrême de végétation. Il nous paraît, en effet, impossible de séparer, au point de vue écologique, des Algues qui ne découvrent jamais de celles qui ne découvrent que brièvement et exceptionnellement.

L'*étage supralittoral* comprend en superposition: d'abord la ceinture du *Xanthoria parietina* (en partie seulement puisque cette espèce peut remonter plus haut jusque

parmi la flore terrestre et descendre jusqu'au niveau moyen des pleines-mers de vive-eau); ensuite la ceinture du *Caloplaca marina* qui débute ordinairement un peu au dessus du niveau moyen des pleines-mers de vive-eau et descend jusqu'au niveau inférieur des pleines-mers de vive-eau; et celle du *Verrucaria maura* dont la limite supérieure coïncide ordinairement avec le niveau supérieur des pleines-mers de vive-eau et la limite inférieure descend jusqu'au niveau moyen des pleines-mers de morte-eau, donc jusque dans la partie tout-à-fait supérieure de l'étage suivant.

L'étage littoral englobe trois sous-étages: le sous-étage supérieur comprenant les deux ceintures superposées du *Pelvetia canaliculata*, allant du niveau supérieur au niveau moyen des pleines-mers de morte-eau et qui peut donc assécher pendant plusieurs marées consécutives, et du *Fucus spiralis*, du niveau moyen au niveau inférieur des pleines-mers de morte-eau; le sous-étage moyen, correspondant à la ceinture du *Fucus vesiculosus* et s'étendant du niveau moyen des pleines-mers de morte-eau au niveau supérieur des basses-mers de morte-eau, et donc s'étendant un peu au-dessus et un peu au-dessous du niveau moyen de la mer; et le sous-étage inférieur correspondant à la ceinture du *Fucus serratus* s'étendant du niveau supérieur des basses-mers de morte-eau au niveau moyen des basses-mers de vive-eau.

L'étage infralittoral enfin englobe, du moins dans sa partie supérieure, la ceinture des Laminaires. Lui aussi comprend deux étages: l'infralittoral supérieur s'étendant du niveau moyen au niveau le plus inférieur des basses-mers de vive-eau et où l'on rencontre d'abord *Laminaria digitata* dans les stations abritées ou, un peu plus bas, *L. hyperborea* et, au-dessous, *Saccorhiza polyschides* dans les stations battues; et l'infralittoral inférieur s'étendant depuis le niveau inférieur des basses-mers de vive-eau jusqu'à la limite inférieure extrême de la végétation.

Ce cas des Laminaires représentées par des espèces différentes suivant que la station est abritée ou battue nous amène à signaler qu'à côté des ceintures constantes de végétation dont nous venons de parler, il existe en effet des ceintures sporadiques (terme préférable à celui de facultatives ou d'inconstantes que nous avons précédemment utilisé): encore que, ne se rencontrant pas partout, elles ne jouent pas le même rôle écologique que les précédentes et ne peuvent servir, par conséquent, à caractériser des étages.

C'est ainsi que, sur les rochers abrités, on observe presque toujours la ceinture du *Lichina confinis* depuis le niveau supérieur des pleines-mers de vive-eau jusqu'au niveau moyen des pleines-mers de morte-eau; et, sur les rochers battus le *L. pygmaea*, depuis le niveau moyen des pleines-mers de morte-eau jusqu'au niveau moyen de la mer. De même, la ceinture du *Rivularia bullata* est ordinairement très bien représentée sur les rochers semi-battus depuis le niveau moyen des pleines-mers de morte-eau jusqu'au niveau moyen de la mer. L'*Ascophyllum nodosum* est constant, mais sur les rochers abrités seulement, depuis le niveau des pleines-mers de morte-eau jusqu'au niveau moyen de la mer. La ceinture du *Nemalion helminthoides* est localisée sur les rochers océaniques battus, depuis le niveau moyen de la mer jusqu'au niveau moyen des basses-mers de vive-eau. Les ceintures du *Bifurcaria tuberculata* et,

en dessous, de l'*Himanthalia elongata* font défaut sur la pourtour des grandes baies; mais ailleurs, elles s'étendent: la première, du niveau inférieur des basses-mers de morte-eau jusqu'au niveau moyen des basses-mers de vive-eau; et, la seconde, s'observe à peu près exactement au niveau moyen des basses-mers de vive-eau.*

En tout cas, après avoir longtemps réfléchi à ce problème, nous ne pensons pas—et c'est une des principales conclusions de cet article—que l'on puisse proposer une classification plus simple ou plus pratique des diverses divisions que l'on puisse introduire dans la région de balancement des marées sur les côtes atlantiques de l'hémisphère Nord. Il n'est pas inutile de souligner par ailleurs qu'il existe un parallélisme étroit entre la situation de ces diverses ceintures et les variations du niveau de la mer: ce qui semble indiquer que c'est l'humectation(et non la température ou la lumière) qui joue le principale rôle dans la répartition de ces organismes, du moins dans la région intercotidale. Sans doute, divers auteurs ont-ils proposé d'autres classifications dont une des plus intéressantes est celle du Pr. Ercegovic, basée exclusivement sur les variations de la lumière et que nous n'avons malheureusement pas la place de reproduire ici.** Elle a l'inconvénient d'introduire de nombreux termes nouveaux: *talantophotique*, *mégaphotique*, *métriophotique*, etc. Cette classification a le grand avantage de pouvoir s'appliquer à toutes les côtes du globe. Malheureusement, en l'absence de mesures physiques systématiques, elle manque de précision. Qu'est-ce qui permet de distinguer à coup sûr une lumière crépusculaire d'une lumière très faible? De plus, du moins dans la région intercotidale, ce n'est certainement pas l'éclairement qui joue le principal rôle dans la succession des ceintures de végétation mais bien, comme nous venons de le rappeler, le temps plus ou moins long et répété d'émersion et de submersion. Enfin cette classification n'est pas pratique, ne se basant pas sur des faits évidents au premier examen. Il n'en est pas de même de notre projet. C'est pourquoi je pense, avec le Pr. Molinier, que la classification du littoral doit être, au moins en partie, biologique car il est plus facile de définir un peuplement que le milieu dont il est la résultante. Sans doute aussi, comme l'a fait remarquer Feldmann, "une espèce n'occupera pas obligatoirement une position déterminée dans un même étage dans le monde entier." Et nous pensons au fait très troublant signalé récemment par Waern au *Colloque sur l'écologie des Algues marines*, Dinard en 1957, que, dans la mer Baltique à mesure que la salinité diminue, le *Fucus serratus*—et même le *F. vesiculosus*—deviennent strictement infralittoraux. Ce fait, s'il s'agit bien des mêmes espèces que celles qui se développent sur nos côtes, est, surtout pour le *F. vesiculosus*, absolument déconcertant; et apparemment en contradiction totale avec tout ce que nous

* On trouvera d'ailleurs le tableau de ces diverses ceintures dans notre travail "Les relations entre les variations du niveau de la mer et la superposition des ceintures de végétation sur le littoral atlantique" in *Acta adriatica*, Vol. VIII, no. 14, Split, 1958 (en le retouchant toutefois en fonction des nouveaux termes et des quelques changements que nous exposons ici).

** On la trouve exposée dans le *Recueil des Travaux de la Station marine d'Endoume*, fasc. 22 p. 17-21, 1957.

savons du comportement de cette espèce sur le littoral atlantique. Mais, ainsi que nous l'avons précédemment signalé (en 1945, à la *Société de Biogéographie*, 16 Novembre 1945), la spécification, dans le genre *Fucus* est souvent difficile et paraît en relation avec la biogéographie des espèces qui le constituent. Peut-être sont-ce des conditions écologiques locales: glaciation à la surface de l'eau de mer et absence de concurrence d'autres espèces qui expliquent cette anomalie de répartition? Quoiqu'il en soit, si on nous objecte ce fait, alors toute classification basée sur la succession des organismes devient impossible, ou, en tout cas, on ne peut plus lui accorder qu'une signification tout-à-fait locale. Bien mieux il nous faudrait réviser les données, apparemment les mieux établies, de l'écologie marine et renoncer, semble-t-il, à toute explication de la répartition des Algues sur nos côtes.

Nous sommes heureux que le Jubilé de Melle Rayss à laquelle nous lie une longue amitié et qui, dans ses travaux sur les Algues de Palestine s'est intéressée à ces questions, nous ait permis d'exposer ces remarques et lui offrir le fruit de nos réflexions en respectueux hommage à sa haute personnalité et à son oeuvre en Phycologie.

TWO NEW SPECIES OF MARINE ALGAE FROM JAPAN

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ABSTRACT

Two following new species of marine algae from Japan are described.

Agarum oharaense. In this species the stipe is flattened and provided with several hapter-like outgrowths at both margins. The blade is provided with many perforations and not bullate, thus the present species showing the intermediate characteristics between *A. cribrorum* Bory and *A. fimbriatum* Harv.

Derbesia rhizophora. The branches of this species are often separated by a partition near their base, and the base of separated branches grows down forming a rhizoid-like prolongation. After decaying of the partition wall the branch becomes separated from the mother-plant.

Agarum oharaense sp. nov.

Radix fibrosa, rhizinis tenuibus, usque ad 4mm crassis, ter vel quater vel quinques dichotome ramosis, ad extremitatem attenuatis; stipite compresso-plano, 5-7 cm longo, ca. 1 cm lato, per partes saepe latiore, ad margines rhizinis fimbriatis; lamina tenuiter coriacea, laevis, non bullata, oblonga vel ellipsoidea vel longe ellipsoidea, 60 cm longa et ultra, ca. 20-25 cm lata, ad basin sine volumine fere rotundata vel ovata, margine leviter undulata, integra vel appendicibus spinulosis brevissimis fimbriata, costa et foraminibus multis praedita; costa continuata, fere omnino plana, levissime crassior quam lamina ipsa, 1.5-2 cm lata; foraminibus numerosissimis, fere aequaliter sparsis, rotundis vel ellipsoideis, margine crenulatis, usque ad 1 cm diam.; soris sporangiorum in margine utrarumque superficierum productis. — (Figure 1).

Japanese name: Ōno-aname.

Locality: Ōhara, Chiba Prefecture, Japan. (Collected by I. Ōno).

Holdfast consisting of fibrous hapters issued from the margins near the base of the stipe; hapters slender up to 4mm diam. near their base, 3-5 times dichotomously branched, attenuated toward the end by means of which the frond is attached to the substratum. Stipe flat, 5-7 cm long, ca. 1 cm wide, often becoming wider partially, often 1-2 times twisted, giving off, more or less abundantly, fimbriate hapter-like often branched, outgrowths on the margins, particularly near the blade. Blade thin, leathery, smooth, not bullate, oblong or elliptical or long-elliptical in outline, ca. 60 cm long or slightly longer, ca. 20-25 cm wide, nearly rounded and without scroll at the base, entire or slightly undulated or furnished with very short spine-like pro-

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tuberances at the margin, provided with a midrib and many perforations; midrib scarcely elevated, boundary between blade itself and midrib often not clear, 1.5–2 cm wide, but clearly thickened part restricted only near the central parts, particularly in the upper portion of the blade; perforations abundant, scattered nearly evenly, mostly nearly circular or sometimes elliptical or ovate in outline, at the margin of large ones blade turned up on one side, large ones ca. 1 cm in diam. Sporangial sori produced on both surfaces near the middle portion of the blade along the margin.

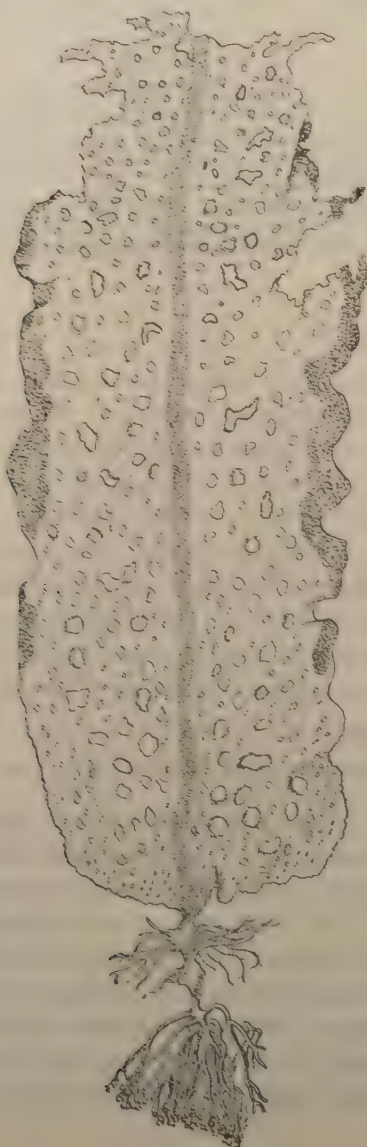


Figure 1

Agarum oharaense Yamada ($\times 1/5$)

The new species seems to be nearly related to *Agarum fimbriatum* Harv. from the western coast of North America, particularly in its flattened stipe which gives off on the margins more or less abundantly fimbriate hapter-like outgrowths and, in the absence of the scroll, at the base of the blade. But the leathery, smooth, not bulate blade of the new species which is provided with rich perforations is the main character distinguishing this species from *A. fimbriatum* Harv. Before describing this new species the writer had a very nice opportunity to observe the living specimens of *A. fimbriatum* in the vicinity of Friday Harbor, Washington, U.S.A. and could compare them with the Japanese specimens. It is very interesting to note that, as is to be seen from the above description, the new species looks as if it were a hybrid between *A. cribrosum* and *A. fimbriatum*.

In some specimens the sori of the unilocular sporangia are found along the margin near the middle portion of the blade as described above, but it seems that they will expand afterwards also to other parts of the blade.

The specimens of the present species were mostly found cast ashore, some, however were taken up by a diver from the bottom of the sea about 17m deep.

***Derbesia rhizophora* sp. nov.**

Frons e rhizoideis repentibus et filamentis erectis composita, densissime implicata, fusco viridis; rhizoideis repentibus crassitudine valde variantibus, plerumque ca. 30μ crassis, valde irregulariter ramosis, nonnunquam coralloideis; filamentis erectis usque ad 1.5 cm altis, filamentosis, plerumque $30-55\mu$, raro 25μ vel supra 62μ crassis; ramis lateralibus vel suboppositis, patentibus, saepe ad basim leviter constrictis, saepe cellula brevi a fronde separatis; ramis separatis saepe ad basim rhizoidem novum emittentibus; chromatophoris discoideis, $2.8-4.2\mu$ diam., pyrenoideis praeditis; sporangiis obovatis vel pyriformibus, apice saepe truncatis, $140-160\mu$ raro 176μ longis, $80-96\mu$ raro 112μ diam., pedicelis ca. $10-20\mu$ raro 30μ longis instructis, in partibus superioribus frondis lateralibus. — (Figure 2).

Japanese name: Nedashi-tsuyunoito.

Locality: Horie pier, Matsuyama, Ehime Prefecture, Japan. (Collected by S. Yagi).

Frond consisting of creeping rhizoids and erect filaments, densely implicate, deep green in colour; creeping rhizoids very variable in thickness, strongly irregularly branched, sometimes coralloid; erect filaments up to 1.5cm high, hair-like, usually $30-55\mu$, rarely 25μ or 62μ thick, branches lateral, occasionally subopposite, patent, slightly constricted at the base, some lower ones separated from the axis by a small septation at their bases, where they often give off a rhizoid-like process downwards; chromatophores discoid, very small, $2.8-4.2\mu$ diam., provided with a pyrenoid; zoosporangia scattered on the upper parts of erect filaments, obovate or pyriform, often truncated at apices, $140-160\mu$, rarely 176μ long, $80-96\mu$, rarely 112μ diam., provided with a short stalk ca. $10-20\mu$, rarely 30μ long, separated from the filaments by a thick stopper, ca. 32 zoospores produced in every zoosporangium.

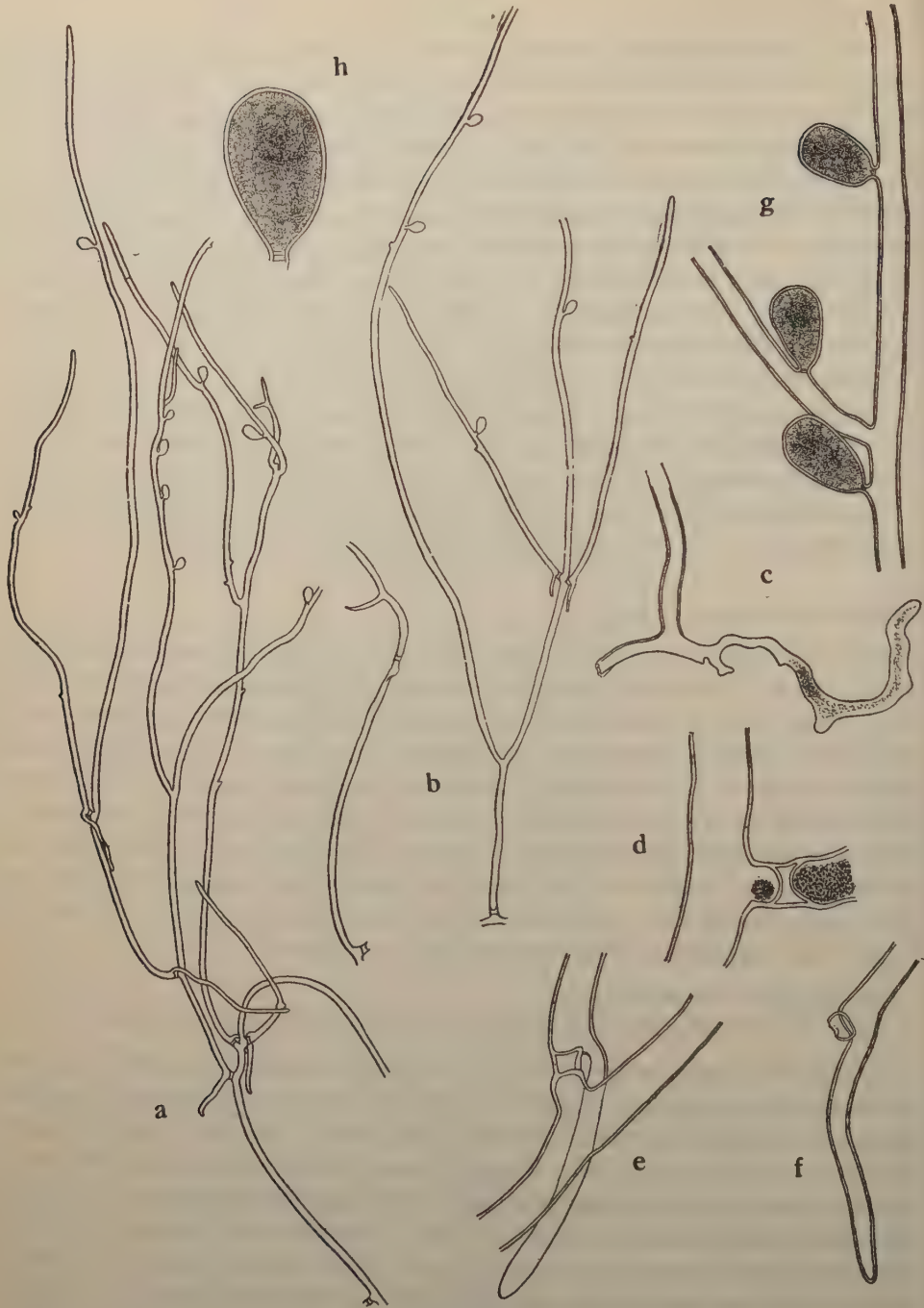


Figure 2

Derbesia rhizophora Yamada. a. and b. Fronds showing habit. ($\times 20$). c. A part of rhizoid ($\times 55$). d. The base of a branch showing the partition. ($\times 140$). e. The base of a branch separated by a partition from the main frond. It sends a rhizoid-like prolongation downwards. ($\times 150$). f. A branch sending a rhizoid-like prolongation which is detached from the main frond. ($\times 115$). g. A part of the frond bearing zoosporangia. ($\times 70$). h. A sporangium. ($\times 80$).

A striking characteristic peculiar to the present species is the presence of partitions found mostly near the base of the branches. Such partitions were already found by several authors, also in *D. marina* Kjellm. but in our species the base of the branches cut off by a partition begins to prolong downwards to form a rhizoidal filament. It is most probable that after decay of the partition membrane the branches which are separated from the main frond and send a rhizoidal filament become independent from the main frond. And this fact seems to the writer to suggest also the meaning of the separations in *D. marina*.

A NOTE ON THE GENUS *LABYRINTHULA* IN ISRAEL

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ABSTRACT

Findings of *Labyrinthula* spp. in the Jordan Valley and on the Mediterranean coast near Haifa are described and biological and ecological aspects of these findings are discussed.

THE *Labyrinthula* SP. OF THE JORDAN VALLEY

In a previous publication the isolation of a *Labyrinthula* species from soil was reported and the behaviour of this organism under various conditions described (Aschner 1958; Aschner and Kogan 1959). Strains of this species were isolated subsequently from the same locality on several occasions and at different seasons of the year. These findings seemed to indicate a regular occurrence of a *Labyrinthula* in a place different from the aquatic habitat in which these organisms are usually found. Further investigation showed, however, that this seemingly terrestrial organism is not necessarily different from the water inhabiting species. The *Labyrinthula* was found only in places irrigated with water from the Jordan River, and it was thought likely that the actual biotope of this organism is the Jordan River or Lake Tiberias which is traversed by this river. This assumption was confirmed by subsequent isolation from both these places of *Labyrinthula* strains, which were identical in every respect with the isolates from soil.

Host plants to the aquatic strains were *Eucalyptus* and *Tamarix* trees which, growing close to the river and the lake, had part of their root system floating free in the water. The presence of *Labyrinthula* in this locality was detected by placing a few small pieces of the "water roots" on a medium consisting of 2% agar-agar in 50% seawater. The fact that in most cases outgrowth of the *Labyrinthula* was visible already after 24–48 hours, and that quite often more than one piece on a single plate was positive, indicates a dense and widespread population of these microorganisms in the root material and justifies the assumption that the soil *Labyrinthula* in the Jordan Valley is derived from this habitat.

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The concentration of chloride in the Jordan River and Lake Tiberias is about 250 parts per million. However, the *Labyrinthula* living in this biotope has a much higher salt tolerance and can be cultivated in media containing undiluted seawater. The creation of a new species on account of the fresh water habitat of this organism seemed, therefore, to be unnecessary, and the species was identified with *L. macrocystis*. It now seems doubtful whether this view can be maintained. Progress in the technique of cultivation made it possible to compare various isolates from different localities under identical conditions and in this way to detect differences which by a purely morphological comparison could not be recognised. It has been found already that the Jordan strains of *Labyrinthula* are definitely different from morphologically similar strains from other localities in Israel.

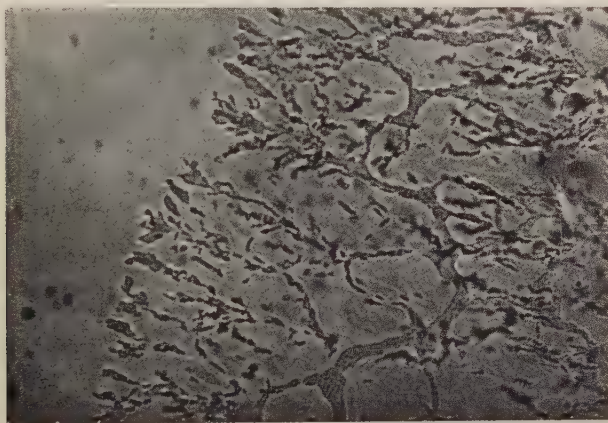


Figure 1

Labyrinthula macrocystis Cienk. from the Jordan river.

(Partial view of a rapidly expanding net plasmodium on sea water agar) $\times 130$

Labyrinthula spp. FROM THE MEDITERRANEAN COAST NEAR HAIFA

From marine algae growing on the coast of Haifa and of Dor, south of Haifa, *Labyrinthulae* were recovered which were morphologically similar to the Jordan species. However, the method of isolation effective with the Jordan strains proved unsuccessful with the marine strains. Their growth and colony expansion on the agar medium, in comparison with the Jordan species, is slow and their utilization of other microorganisms less effective. Bacilli, amoebae and moulds usually overgrow the plates before the netplasmodium is sufficiently developed. Isolation was accomplished only by flooding the agar plates before the inoculation with an aqueous solution of penicillin and streptomycin containing 50 $\mu\text{g}/\text{ml}$ of each substance. It seems that the flooding of the plate is in more than one way favourable for the development of the marine *Labyrinthula*: Apparently by inhibition of bacterial

growth the development of amoebae is slowed down, and the surface film which remains on the agar as a result of the flooding permits a better extension of the netplasmodium than the dry agar surface which is well tolerated by the Jordan species. The marine strains did not form sori or sporangia on the agar medium and their netplasmodia even under the best conditions were never as large or as regular as the corresponding growth figures of the Jordan strains.

While cultivation of this marine species with living yeast cells as food is possible, it is not always successful. A more regular and better growth was obtained with a mucoid strain of *Rhizobium* instead of yeast. The reason for the enhancing effect of this organism is not known. It might be simply the special physical conditions in the bacterial slime mass which influence the *Labyrinthula* cells favourably.

The distribution of this species along the coast of Israel has not yet been studied, but in the two localities mentioned, it has been isolated already several times and seems, therefore, to be quite common. It was found on several species of algae of which the following three species have been determined: *Ulva lactuca*, *Laurencia papillosa*, *Cystoseira abrotanifolia**. The marine *Labyrinthula* is considered to be identical with *L. vitellina* Cienk.

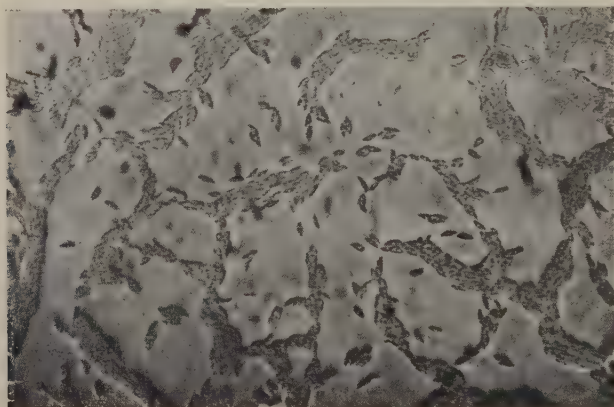


Figure 2

L. vitellina Cienk. from the Mediterranean coast near Haifa
(Part of a net plasmodium on sea water agar) $\times 150$

The locality in Dor where the above mentioned species was found was also the habitat of an organism identical with or closely related to *L. minuta* Watson et Raper. This organism seems to be even more common than the aforementioned *Labyrinthula*. In a batch of ten different algal species collected from one locality no less than the following eight contained this organism: *Ulva lactuca*, *Spyridia*

My thanks are due to Prof. T. Rayss who kindly determined all the algae spp. mentioned in this paper.

filamentosa, *Laurencia papillosa*, *Hypnea musciformis*,¹ *Cystoseira 'abrotanifolia*, *Colpomenia sinuosa*, *Cystoseira discors*, *Padina pavonia*. The two species which did not yield positive cultures were *Dictyota dichotoma* and *Jania rubens*. The possibility is not excluded that these algae too would have been positive if larger pieces or more than one plant had been examined. For isolation and cultivation the same methods as for the other *Labyrinthula* were employed. However, in contrast to the other species described this organism was able to develop normally on a simple sea water agar medium without any addition of yeast cells or other microorganisms as food, and such cells, when added, were not utilized by it. Furthermore the growth figure developing under these conditions has very little resemblance to a netplasmodium, in formation as well as in organisation.

These differences, in addition to those cited by Watson and Raper (1957), separate this species sharply from all other known *Labyrinthulae*, and it seems questionable whether its inclusion in this genus is justified. It is intended to present a more detailed description of this species and a discussion of its taxonomic position in a future publication.

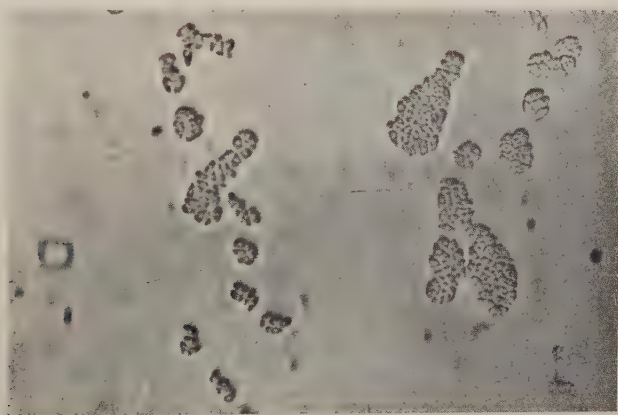


Figure 3

L. minuta, Watson and Raper from the coast near Haifa
(Division of cells into tetrads on sea water agar) $\times 250$

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STUDIES ON PLANT SEMIOTICS

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ABSTRACT

The need to group the diseases on the basis of their own pathogenic characteristics, that is on the basis of the relationship between the pathogenous agent and the plant, is discussed. The following groups are studied: epiphytic diseases; trophic diseases; auxonic diseases; dishydrotic diseases; lytic diseases; xylochereutic diseases.

Until now only little attention has been paid and few results achieved in the study of semiotics in plant pathology, although there has been no lack of examples.

An attempt is made here to group the diseases together on the basis of a new line of research.

This not only regards a classification based on the most characteristic symptoms of the diseases instead of on etiological agents; it also concerns the need to group the diseases on the basis of their own pathogenic characteristics, that is, on the basis of the relationship between the pathogenous agent and the plant. The analysis of this relationship enables an arrangement of semiotic groupings which facilitates diagnosis, study and research in a way which better corresponds to scientific requirements.

The interest created by the semiotic groups is evident. They suggest how the diseased plant should be observed, how to take samples and discover their antecedents, from climate to cultivation; they indicate a line for laboratory research and, finally, enable a proper determination of initial diagnostic elements. More notable results are achieved in teaching. In such presentation of the subject those students or experts who study plant pathology find a clear and easy way of establishing the fundamental points. As long as pathology is taught etiologically it is found difficult because it is mnemonic, because it lacks a guide to the subject itself and rather seems to be a systematic grouping of pathogenous microorganisms. In research, the analysis of the relationships between pathogenous agents and plants opens up new possibilities of original findings which may be interesting and important from the point of view of widening our knowledge and also their applications.

In the following the groupings established by us are listed.

* Received May 4, 1960.

EPIPHYTIC DISEASES

At the outset the disease is considered as a struggle between two organisms, the plant or host or susceptible and the pathogen. Observation tells us about the relationship which exists between these two organisms.

We all know the ivy clinging to the tree; its heavy foliage prevents light from reaching the tree and reduces its respiratory and transpiratory activity. Let us take this first relationship—tree to ivy—as the prototype of a first disease grouping and call them *epiphytic* diseases, that is something superimposed on another.

Other examples of this type of disease are supplied by “sooty mould”. But the presence of sooty mould is determined by honey dew found on plants following warm, damp weather, or excessive stinging by insects, particularly by scale insects and aphids. The disease now becomes complex. Attacked by living agents such as insects, or by the deleterious effect of climate and by nutritional irregularity, the plant finds itself in a state of physiological unbalance and loses substances from its leaves on which moulds develop. The disease is no longer a question of direct relationship between two organisms, but becomes a phenomenon consequent on a set of factors which have a complex interaction.

TROPHIC DISEASES

We can make a second grouping of diseases where the relationship between plant and pathogen agent is no longer solely epiphytic, but has an anatomic substratum: the pathogen does not only grow over the host plant but establishes a tissue connection. Let us take the example of mistletoe. Here there exists an anatomic connection formed by the cones of the mistletoe which penetrate into the plant and there is also nutritional exchange between the pathogen and the susceptible. In these cases we use the term “parasitism”.

Parasitism of one plant on another is characterised by the well-known anatomic connection or haustoria; but there is also an anatomic connection at cell level in the case of parasitic fungi and this is also called haustoria.

We call these diseases *trophic* or *symbiotic* because there is an initial stage when the connection is typical of symbiosis.

N. Bernard defined symbiosis as “the border line of illness” and symbiosis is useful in the study of disease since, at the beginning, there is a stage of nutritional balance between the pathogen and the susceptible which slowly alters in favour of the former. There is a whole range which gradually passes from the so called tropical epiphytic diseases, like *Meliola*, to the powdery mildews, the rust fungi, the downy mildews and, finally, to those diseases caused by smut fungi where the symbiotic relationship is continued throughout the whole plant for the full duration of the vegetative period. In these plants we see the actuation of a basic nutritional factor; it is no mere coin-

cidence that in nearby all cases there is an "obligate parasite" which has a living connection with the host plant's cells, and these die off as the final stage of a cycle of nutritional exchange.

AUXONIC DISEASES

Fungi and bacteria may establish a kind of relationship with plants which extends beyond the question of nutrition. The pathogenous growth not only obtains substances from the plant which it is not able to produce itself, but has a direct influence on its development and finally alters the morphogenesis of the plant.

This is the fact which we had not observed in previous cases; it is well known and of considerable diagnostic interest although there is no need to dwell on it at length. We can call this group *auxonic diseases*. They are diseases which involve a disturbance of the regulation of development both of the cells and of the plant in a general sense. Among the etiological agents we not only find living organisms, fungi, bacteria and insects, but also viruses, nutritional deficiency, several chemicals such as ethylene and more complex organic substances such as synthetic auxins.

DISHYDROTIC DISEASES

In the preceding groupings the disease appeared in the form of a competition of an alimentary or auxonic nature. The cell which feeds the haustoria is a turgid vegetable cell and remains so for some time. The maintenance of this water balance is fundamental for the absorption of substances by this parasite, whether these be sugars, mineral salts, nitrogenous substances or vitamins. The cells remain turgid under the auxonic stimulus all the same.

On the other hand the new group represents a competition as regards water exchange in the cell. The plant might be described as an organism made up of cells continually requiring water one from the other. The possibility of being able to regulate the balance between water absorbed and water lost is fundamental to the life of a cell. For example, the water required during the full cycle of development of a maize plant is divided as follows (Miller, 1938):

Water lost in transpiration	202,106 grams
Water required as a constituent	1,872 "
Water used as a reagent	250 "
Total	204,228 grams

It follows that 99 % of the water total passes through the plant with the sole purpose of maintaining the correct water balance in the cells such as will ensure their functioning, that is, their remaining turgid. From this point of view the plant is a hydrostatic organism which regulates and maintains a fixed level of water in its organs.

Plant physiology lists numerous factors which, during the life of the plant, act on this balance in various ways. Apart from the obvious one of scarcity of water in the soil, the influence of the environment temperature and of the oxygen round the roots is to be remembered. If oxygen is lacking in the soil the roots absorb less water because the respiratory activity of the root hairs is reduced. Low temperatures reduce the absorption of water to the point where at 0°C it is reduced to 50% of the absorption rate at 20°C.

The loss of water regulating capacity by the cells is the salient fact in these diseases which we may call *dishydrotic*: the interruption of cellular hydric permeability appears as the first phenomenon in this group of diseases, either when inorganic factors are present, such as certain gases, for example SO₂, F₂, Cl₂, or when climatic factors such as sharp thermal variations occur (colder or hotter), or if parasitic agents are active through toxins or protoplasmic poisons (e.g. vivotoxins). In all these cases the cell loses water rapidly and, as rapidly, dies. The semiotics of these alterations are expressed in the form of drying of the tissues. Cellular dehydration also appears in the other groups of diseases already listed, but is posthumous or secondary in the pathogenetic process. In the cases of the trophic and auxonic diseases the parasite has taken its requirements from living cells; in these diseases, on the other hand, the parasite kills the cell and subsequently behaves like a saprophyte (pertosphyte).

A particular case of these diseases occurs when there is localisation of the parasite in the trachea with injury not only to the permeability of the cells adjacent to the vessels but also with gas emboli or with physical stoppage of the vessels with gums and mucilages, for which reason such diseases might be connected with the pectolytic diseases, which are mentioned below.

LYTIC DISEASES

We now have two groupings in which the supporting or non-vital structures of the plants are primarily involved in the relationship between pathogenous agent and plant. One of these groups concerns the diseases described as *lytic* diseases. Pathogenous micro-organisms with specific enzymes dissolve the middle lamellae which means that the cells are no longer held together; these are described as *pectolytic*. Many *gummosis* diseases are considered analogous. The gum originates in the destruction of the lignified cell walls and in the constituents of the cytoplasm. Although a great deal of research has been carried out in this connection, little is known about the inner process from which this gum originates. It may be formed not only by parasitic attacks but also following injury.

A third form which the lytic diseases take is *resinosis* and is accompanied by a production of resin. There are examples of this in the pistachio and olive. A fourth is the *slime-flux* form where there is the formation of mucilaginous substances, as

in the elm for example. Processes in which other inactive tissues are concerned may also be included, for example the destruction of the cuticle where *Cycloconium oleagineum* is parasitic on the olive.

XYLOCHEREUTIC DISEASES

These are characterised by the destruction of the lignified tissues by the pathogenous growth. An example of this is the destruction of the wood by Basidiomycetes. The process is generally slow and tends to become chronic, that is, the plant dies after a long while and often for accidental reasons.

AIR-BORNE FUNGI IN PACKING HOUSES FOR CITRUS FRUITS*

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ABSTRACT

For the study of air pollution by fungal spores in the mechanised packing houses for citrus fruits, spores were collected from the air by the culture-plate method. That enabled identification of the parasitic and non-parasitic species.

Plates were exposed at different fixed sites in three packing houses and their courtyards, during the packing season and after its conclusion.

The parasitic molds *Penicillium digitatum* and *P. italicum* were typical to the air of the packing houses and their vicinity. Other parasitic fungi of citrus fruits, such as *Fusarium*, *Trichoderma*, *Colletotrichum* and *Diplodia* were only rarely found.

The largest number of air-borne fungi were obtained from the area where fruits were unloaded from field boxes. These peaks were due to the increase in the number of the common air-borne fungi of which *Cladosporium* predominated.

After the end of the packing season no differences in the number of fungi collected were found at the different sites of exposure. At the same time a marked decrease in the total number of the air-borne fungi was noted.

INTRODUCTION

In connection with both the development of the mechanised packing houses for citrus fruits and the striving to improve the preservation and packing of the fruits, an increased interest has been aroused in the problem of air pollution by fungal spores in the packing houses.

The atmosphere of packing houses contains spores of various saprophytic and parasitic fungi. Among them the species which are responsible for fruit rots are of special importance. These spores may constitute a real danger in the packing house by causing rot of the citrus fruits under favourable conditions.

The packing house could be divided into several typical areas: the area of the unloading of fruits from field boxes into grading belts; the area of washing, disinfection, drying and waxing, and the area of classification, wrapping and packing of fruits. All these areas are under one roof and usually are not divided by any partitions. In such packing houses there exist therefore special factors which may affect directly or indirectly the air-borne spores.

Indirect factors may be air drafts through the wide openings in the walls, movements of unloading field-boxes, movements of conveyor belts carrying the fruits and the packing boxes, drying fans and the workers' movements. Direct factors

* Publication of the Agricultural Research Station, Beit Dagan-Rehovoth, 1960 series, No.340-E.

affecting the air spora are spores-sources such as field and packing boxes, as well as infected fruits in the packing houses and their vicinity.

Some investigation on air-borne fungi in packing houses and citrus groves in Israel were made by Ben-Meir (1952).

The present work aims to give an answer to the following questions: (a) Is there a characteristic air-spora in the packing houses and if so, what is its qualitative and quantitative composition? (b) What is the distribution of the atmospheric spores in the same packing house in its different mentioned areas? (c) Is there a seasonal variation in the occurrence of the atmospheric spores in the packing houses and their vicinity?

METHODS AND MATERIALS

Spores were collected from the air by the culture-plate method. As compared with the volumetric spore traps (Hirst 1952, Gregory 1954) the culture-plate method is of a low efficiency in collecting the air-borne spores. However, in the spore-trap method there is difficulty in identifying the spores collected on the slides. In this respect the plate method was found to be more satisfactory; it enabled differentiation between the two parasitic species of *Penicillium*, *P. digitatum* and *P. italicum*, as well as between these species and the many non-pathogenic *Penicillia* present in the atmosphere of the packing houses.

Standard Petri dishes containing potato-dextrose-agar were exposed horizontally to the atmosphere for 1 minute each. Exposures were conducted in three packing houses in which fruits were submitted to two different disinfection methods: (a) at "Beit-Hanan" where packed fruits were disinfected by gassing with NCl_3 (Klotz 1936, Littauer 1947), while (b) in "Tnuva" — Rehovot, and (c) in "Polani" — Rehovot, disinfection was made by dipping the fruits in Borax solution (Winston 1935). Furthermore, in Tnuva's packing-house all operations were carried out in one hall, while in Polani's packing-house grading and packing of fruits were carried out in a separate place from that of the washing and disinfection.

Exposures were carried out in each packing house in different fixed sites: (1) in the area of unloading of fruits, (2) and (3) in two places among packers and (4) in the courtyard of the packing house. In Beit-Hanan plates were exposed in an additional indoor place: in the gassing room.

For comparison additional plates were exposed in the courtyard of the Agricultural Research Station in Rehovot in a distant place from the packing houses.

In each instance three plates were exposed simultaneously. Exposures were conducted twice a week from December 1956 till the end of April 1957. Control exposure was carried out after the conclusion of the packing season at the end of June, in each of the above mentioned packing houses at their fixed exposure sites.

RESULTS

After an incubation of 4–10 days at room temperature, the developed fungus colonies were examined. The total number of recorded colonies contains also those of Actinomycetes but not colonies of yeasts and bacteria.

In order to make a quantitative comparison of the total number of colonies in the different examined areas, numbers of colonies were summed up for the whole period of exposure (26 series of exposures) in each of these areas (Table 1).

TABLE I

Total number of colonies at the different sites of exposure for each of the three packing houses and comparison place, during the packing season (12/56 — 4/57)

Place of exposure	Site of unloading of fruits	Among packers	Among packers	Gassing room	Courtyard of packing house	Courtyard
Beit-Hanan	2628	1533	1242	534	594	
Tnuva	5070	1571	1509	—	621	
Polani	3186	1185	1179	—	993	
Agr. Res. Station	—	—	—	—	—	453

Table 1 shows that the highest number of colonies was obtained from exposures made in the area of unloading fruits from the field boxes. Their total number in the three packing houses during the whole period, amounted to approximately 2600 to 5000 colonies. There were not significant differences in number of colonies obtained in the two sites among the packers in each of the packing houses. Furthermore, the total numbers for this area varied only little with the three packing houses.

Number of colonies collected outdoors, in the courtyards of the packing houses, was lower than those gained indoors among the packers (in Beit-Hanan and Tnuva) or almost equal (in Polani).

Number of colonies gained in the gassing-room in Beit-Hanan was either slightly lower or similar to those gained outdoors.

The lowest numbers of colonies, however, were found in the "comparison place" in the courtyard of the Agricultural Research Station.

Results from control exposures made after the end of the packing season, during the last week of June, are shown in Table II. Two series of exposures were made and their average per plate was compared with that calculated for the packing season.

Table II shows that the number of colonies per plate after the end of the packing season is lower than that obtained during the season. It also shows that after the end of the packing period there were no significant differences in colonies numbers in the various areas in the packing house.

TABLE II

Average number of colonies per plate after the end of packing season (June 1957) compared with that for the packing season

Place of exposure	Beit-Hanan		Tnuva		Polani		Agr. Res. Station	
	During the season	After the season	During the season	After the season	During the season	After the season	During the season	After the season
Site of unloading of fruits	34	6	65	11	41	10		
Among packers	20	15	20	9	15	8		
Among packers	16	12	19	10	15	14		
Gassing room	7	8						
Courtyard of packing house	8	6	8	11	13	9		
Courtyard							4	8

Genera and species of air-borne fungi in the packing houses.

The genera of fungi collected from the atmosphere in the packing houses belong to the typical air-borne fungi. The following genera and species were found during the tested period, and are recorded according to their incidence:

<i>Cladosporium (Hormodendrum) sp.</i>	<i>A. versicolor</i> (Vuill.) Triaboschi
<i>Cladosporium herbarum</i> (Fres.) Link	<i>A. sydowi</i> (Bain. and Sart.) Thom and Church
<i>Alternaria tenuis</i> Nees	<i>A. flavus</i> Link
<i>Stemphylium botryosum</i> Wallroth	<i>A. nidulans</i> (Eidam) Winter
<i>S. verruculosum</i> Zimmerman	<i>A. terreus</i> Thom
<i>Penicillium digitatum</i> Sacc.	<i>A. flavipes</i> (Bain. and Sart.) Thom and Church
<i>P. italicum</i> Wehmer	<i>A. ochraceus</i> Wilhelm
<i>P. stoloniferum</i> Thom	<i>A. ustus</i> (Bain.) Thom and Church
<i>P. frequentans</i> Westling	<i>A. fumigatus</i> Fresenius
<i>P. oxalicum</i> Currie and Thom	<i>Fusarium sp.</i>
<i>P. chrysogenum</i> Thom	<i>Trichoderma lignorum</i> (Tode) Harz
<i>P. purpurogenum</i> Stoll ver. <i>rubrisclerotium</i> Thom	<i>Pullularia pullulans</i> (de Bary) Berkhout
<i>P. jenseni</i> Zaleski	<i>Helminthosporium anomalum</i> Gilman and Abbott
<i>P. brevi-compactum</i> Dierckx	<i>H. sativum</i> Pammel, King and Bakke
<i>Rhizopus nigricans</i> Ehrenberg	<i>Pleospora herbarum</i> (Pers.) Rabenh.
<i>Epicoecum nigrum</i> Link	
<i>Aspergillus niger</i> Van Tieghem	

<i>Mucor</i> sp.	<i>Nigrospora spaerica</i> (Sacc.) Mason
<i>Monilia</i> sp.	<i>Diplodia natalensis</i> F.E.
<i>Botrytis cinerea</i> Pers.	<i>Verticillium</i> sp.
<i>Spicaria</i> sp.	<i>Hormiscium</i> sp.
<i>Trichothecium roseum</i> Link	<i>Curvularia</i> sp.
<i>Colletotrichum gleosporioides</i> Penz.	<i>Cephalosporium curtipes</i> Sacc.
<i>Stachybotris atra</i> Corda	<i>Periconia byssoides</i> Pers.

In the list of fungi we also included colonies with sterile mycelium which could not be identified. In addition, two genera of Actinomycetes were recorded: *Micromonospora* and *Streptomyces*.

The high numbers of colonies which were obtained from the site of unloading fruits, contained mainly an abundance of the common air-borne fungi, of which the most predominant was *Cladosporium* (*Hormodendrum*). This mold belongs to the typical common air-borne fungi and is not specific to these particular places (Barkai-Golan 1958). The number of *Cladosporium* colonies alone, in the unloading site at "Tnuva" packing-house for instance, amounted to 3381 out of 5070 colonies collected. The remaining colonies were composed of other saprophytic fungi in small numbers and of fungi parasitic to citrus fruits.

Among the parasitic fungi *Penicillium digitatum* and *Penicillium italicum* were the most abundant. Other parasitic fungi as *Fusarium*, *Trichoderma* and *Colletotrichum* were observed in very small numbers, while *Diplodia* was rarely found.

In the other sites of exposure, *P. digitatum* and *P. italicum* were also the most important and their number was only little lower than that found at the unloading site.

The number of colonies of *P. digitatum* recorded in the packing houses and their courtyards was 2.5 to 13 times greater than those found in the comparison place which was far away from the packing houses (Table III). The number of colonies of *P. italicum* collected in the packing houses and their yards (Table IV) was 2-20 times greater than those collected at the comparison place.

These results indicate that packing houses and their vicinity constitute an area in which the incidence of *P. digitatum* and *P. italicum* is very high during the packing season.

Of these two fungi, spores of *P. digitatum* were more abundant. Their rate amounted generally to 5 - 30% of the total of colonies per plate. The rate of *P. italicum* amounted to 2 - 15% of the total number of colonies.

An increase in the amount of *P. italicum* in the air was noted towards the last part of the packing season. On the other hand no significant changes in the rate of *P. digitatum* were observed.

TABLE III

Total number of colonies of *P. digitatum* in the packing houses and in comparison place during the packing season (12/56 — 10/57)

Place of exposure	Site of un-loading	Among packers	Among packers	Gassing room	Courtyard of packing house	Courtyard	Total number (without gassing room)
Beit-Hanan	390	303	204	66	111		1011
Tnuva	195	156	168		72		591
Polani	291	210	216		156		873
Agr. Res. Station						30	

TABLE IV

Total number of colonies of *P. italicum* in the packing houses and in comparison place during the packing season (12/56 — 4/57)

Place of exposure	Site of un-loading	Among packers	Among packers	Gassing room	Courtyard of packing house	Courtyard	Total number (without gassing room)
Beit-Hanan	240	114	69	27	21		444
Tnuva	159	108	66		33		488
Polani	207	72	102		87		468
Agr. Res. Station						12	

DISCUSSION AND CONCLUSIONS

The quantity of air-borne spores in the different sites of exposure, was found to be similar in all the three packing houses. The number of spores at the different sites of exposure among the packers did not differ much from one another in the three packing houses despite the different disinfection methods employed and the difference in the character of the packing houses. On the other hand the number of colonies collected at the site of unloading was in all the packing houses, much higher than those collected at the other sites. These peaks in colonies' number were due to the increase in the number of the common air-borne fungi. This increase in the spores number was probably caused by the heavy dust produced by throwing and overturning the field boxes. Among the parasitic fungi, *Penicillium digitatum* and *P. italicum* were the most abundant. Of these two fungi *P. digitatum* was more frequent. Towards the end of the season the number of *P. italicum* spores had increased and became almost equal to that of *P. digitatum*, or in some instances even surpassed them. The spore-number of the two penicillia obtained in the comparison place far away from the packing houses, was much lower than that found in the packing houses.

Other parasitic fungi such as *Fusarium*, *Trichoderma*, *Colletotrichum* and *Diplodia* were found only in small quantities. Among the saprophitic fungi the genus *Cladosporium* (*Hormodendrum*) predominated.

At the end of the packing season the number of colonies collected was much lower than that obtained during the season. Furthermore, no significant differences in colonies number in the different sites of exposure was noticed.

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AMOEBIDIUM PARASITICUM CIENKOWSKI – A TRICHOMYCETE
GROWING ON *DAPHNIA* SP.

First record from Israel

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ABSTRACT

The Trichomycete *Amoebidium parasiticum* Cienk. is recorded as growing on the exoskeleton of Daphnias in Israel. A morphological study of its vegetative stages, as well as the way of reproduction by spores is reported.

INTRODUCTION

Among the mycological reports on the "Trichomycetes"* relatively few deal with the Amoebidiales. The members of this order, which consists of two families and two genera, are known to be filamentous fungi attached to the exoskeleton and the rectum of fresh-water Arthropoda. They reproduce by spores of several types, one of them amoeboid.

Amoebidium parasiticum was first described by Cienkowski (1861), who found it on the exoskeleton of fresh-water Crustacea and in insect-larvae. Other workers** described new species and contributed additional data to an understanding of the life-cycle, cytology and ecology of this organism. All the accumulated data are well summarized in the comprehensive study by Tuzet and Manier (1951), in whose opinion all the species should be included in *A. parasiticum* Cienkowski. However, many questions relating to their systematic position and affinity to the host (are they ectoparasites or ecto-commensals?) are still open, and all mycologists who have studied this group are in accord that our knowledge of the biology and distribution of these strange organisms is insufficient.

OBSERVATIONS

In January 1959, our attention was directed to a "fungal disease" on Daphnias cultured in fresh-water tanks in the Department of Zoology at the Hebrew University, Jerusalem. The swimming Crustaceans were surrounded by a white zone, especially

*According to Duboscq Léger and Tuzet (1948).

**Moniez (1887); Labbé (1889); Chatton (1906); Raabe (1912); Lichtenstein (1917a, b); Taylor (1928); Duboscq, Léger and Tuzet (1948); Manier (1959).

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around the antennae, but they did not seem to be very much damaged by the fungus. They continued to move and multiply, although dead animals were found on the bottom of the tank. Microscopic examination revealed that the white zone on the live and dead animals was composed of a fungus belonging to the Eccrinides. The material was preserved in a solution of 4% formol for further examination. Observations and studies of the preserved material proved the organism to be *Amoebidium parasiticum* Cienkowski.

The fungus, whose body is composed of a relatively long unicellular filament and a holdfast was found all over the carapax and legs of the Daphnias, but especially crowded on the antennae (Figure 1). Some of the Daphnias "carried" more



Figure 1*

General view of an antenna bearing the Amoebidia. ($\times 69$)

Amoebidia than the others, and a few were even free of the fungus. In general many stages of development could be seen on a single host. Bacteria were attached to the holdfasts in many cases.

* All the photomicrographs are of specimens mounted in lactophenol containing cotton blue.

Young organisms are lunate and contain 1–4 nuclei. They attach themselves to the host and begin to elongate. The nuclei divide, up to 20–30 in each cell, and are arranged in a single row. As they continue to divide they become distributed irregularly within the elongated cells. Besides the nuclei, the protoplasm contains many granules and vacuoles, some of them giving the reaction for lipides after staining with Sudan III. The adult vegetative filaments are straight or curved, and measure 120–190 μ in length and 7.5–14.5 μ in diameter, mostly 140 by 12 μ (Figure 2).



Figure 2

Different vegetative stages of *A. parasiticum* Cienk. attached to the spine on a leg ($\times 237$).

The protoplasm soon cleaves to form many elongate spores, each of which contains 1–4 nuclei. The numerous and compact spores (25–50 and more per cell) tend to be arranged with their long axis parallel to the longitudinal walls of the cells, which now serve as sporangia. They are soon discharged through several pores in the thin sporangial wall (Figure 3). The spores are lunate, like young organisms, and measure 12–32 μ by 3.6–5 μ . They seem to be identical to the spores described by Chatton (1905), the endoconidia described by Lichtenstein (1917) and the germs described by Tuzet and Manier (1951).



Figure 3

Mature sporangia discharging their spores. ($\times 237$).

Unfortunately, neither amoebae nor cysts could be seen in our material, as preserved specimens were studied. No evidence was found that the organisms formed the "bouquets" of vegetative hyphae, as described by Tuzet and Manier (1951) but some hyphae did show cleavage to form bifurcate branches in their upper portion (Figure 4).

CONCLUSIONS

A. parasiticum has been recorded from Europe, America and Indo-China (Manier 1950). This species was first considered as an ecto-parasite, but more recent experiments and observations by Chatton (1906), Tuzet and Manier (1951) and others support the opinion that it is an ectocommensal, for which the host serves only as a place for growth and transportation, and the nutrients are absorbed throughout the outer surface of the cells from the surrounding liquids. In the present case this liquid



Figure 4
Bifurcate vegetative hypha. ($\times 593$).

was rich in decaying organic material, and it seems that it is favourable for the development of the Amoebidia.

This is the first record of a Trichomycete from Israel, and it adds support to the opinion that this group is world-wide in its distribution. More observations will undoubtedly reveal it, as well as other species of the group, in other locations and on other hosts in Israel.

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POWDERY MILDEW ON LEAVES OF GROUNDNUTS

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Powdery mildew appears on cultivated groundnuts as distinct spots covering the upper side of the leaflet. Occasionally the margin and leaflet midrib are similarly affected, the infected parts becoming reddish-brown. Mildew is rare on the lower side of leaflets, and when it does occur its colour is of a lighter shade.

The powdery mildew consists of a superficial hyaline mycelium spreading along the surface of the leaflet, and of conidiophores with conidia.

Length of mycelium cells is 17–35 μ , their width 5–7 μ . Conidiophores comprise 2–3 cells, their length being 12–28 μ and width 6–9 μ . conidiophores bear 1–2 conidia; conidia are oblong, their length is 24–34 μ (mostly 27–31 μ), their width is 11–16 μ (usually 11–15 μ).

Powdery mildew was found for the first time in Israel at Ein Vered in the coastal plain on July 18, 1941, and at Raanana in the same region on August 15, 1943. The disease was again encountered at Hulata in the Huleh Valley on October 28, 1943. No instance of powdery mildew on groundnuts has been found in Israel since and no occurrence of the disease has hitherto been recorded in any country, where groundnuts are cultivated.

Oidium arachidis Chorin sp. nov.

Caespitulis in maculas coalescentibus, amphigenis, praecipue in superiore parte foliorum originariis. Conidiophoris paucis, 2–3 septatis, 12–28 μ longis et 6–9 μ latis. Conidiis oblongis, 24–34 \times 11–16 μ , hyalinis, singulis aut binis, facillime secedentibus.

Hab.: in foliis vivis *Arachidis* hypogaeae. in Israel.

The powdery mildew found on *Arachis* leaves in Israel may in our view be considered a new species of *Oidium*.

As no perithecia were found it is difficult to say to which genus it may belong. The big conidia of this species suggest their identity with *Oidium erysiphoides* Fr. and consequently their belonging to *Erysiphe polygoni* DC., as suggested by Viennot-

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Bourgin (1949). But as *Oidium erysiphoides* Fr. has been differently understood, we agree with Blumer (1) in considering it as *nomen nudum* and it has therefore to be excluded.

A new description is therefore given and a new name of *Oidium arachidis* sp.nov. is proposed for the time being.

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A NEW SPECIES OF *STROMATINIA* ON *SANGUINARIA*

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ABSTRACT

Stromatinia sanguinariae is described as a new species occurring on rhizomes of *Sanguinaria canadensis*. This species lacks a conidial state and has the stroma differentiated into two types, a manteloid stroma and sclerotules. It provides evidence that *Stromatinia* is a well founded genus since it shows a relationship between *S. rapulum* (Bull.) Boud. and *S. gladioli* (Drayt.) Whetz.

The genus *Stromatinia* was erected by Boudier (1907) and characterized as having apothecia arising from a stroma covering the organs on which it developed and not differentiated into sclerotia. He included in this genus a number of species which are now distributed among other genera such as *Ciboria*, *Monilinia*, and *Gloeotinia*. Boudier did not designate a type species but Honey (1928) suggested that *S. rapulum* (Bull.) Boud. which was the first species listed should be chosen as the type. No conidial state was known in *S. rapulum*. Species with a monilioid conidial state which had been placed in *Stromatinia* by Boudier were transferred by Honey to his genus *Monilinia*.

Nannfeldt (1932) treated *Stromatinia* as a synonym of *Sclerotinia* but accepted *S. rapulum* as the type of *Stromatinia*.

Whetzel (1945) took up the genus *Stromatinia* Boud. and definitely designated *S. rapulum* as the type. Whetzel's concept of the genus was, however, based largely on *Stromatinia gladioli* (Drayt.) Whetz. which had been studied extensively in culture whereas *S. rapulum* had not. In spite of the fact that *S. rapulum* was imperfectly known Whetzel believed that it and *S. gladioli* were congeneric and that *Stromatinia* was the earliest legitimate generic name for fungi of this type.

As emended by Whetzel (1945) *Stromatinia* was characterized by two distinctive features, the lack of a conidial state, and the differentiation of the stroma into two forms. The first of these is a relatively thin, subcuticular stroma forming a mantle-like sheath around the substrate and it is from this manteloid stroma that the apothecia arise. The second form consists of minute, black sclerotia borne free on the mycelium and apparently only vegetative in function. He termed these structures sclerotules. On the basis of these sclerotules Whetzel transferred *Sclerotium cepivorum*

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Berk. to *Stromatinia*, although he had never seen either apothecia or the manteloid stroma in this species.

Drayton and Groves (1952) described another species occurring on the outer scales of *Narcissus* bulbs as *Stromatinia narcissi*. This species is obviously congeneric with *S. gladioli* and these two fungi constitute the only species in the genus of which the life history has been carried through completely in culture. However, in both of these species apothecia have been found only in culture and never in nature.

Buchwald (1949) suggested that *S. pseudotuberosa* (Rehm) Boud. [*Ciboria bat-schiana* (Zopf.) Buchw.] be chosen as the type of *Stromatinia*. This would have the effect of reducing *Stromatinia* to synonymy with *Ciboria* and Buchwald did, in fact, treat it as a subgenus of *Ciboria*. It would then become necessary to create a new genus for species such as *S. gladioli* and *S. narcissi* and presumably also *S. rapulum*. This would seem to be undesirable when *Stromatinia*, which is an eminently suitable name, is available for them if typified by *S. rapulum*. Furthermore, since the typification of *Stromatinia* by *S. rapulum* was proposed earlier it should stand unless very cogent reasons can be given for rejecting it.

The disadvantage of choosing *S. rapulum* as the type is that there is uncertainty regarding both its identity and its life history. The fungus was originally described by Bulliard (1791) as *Peziza rapulum* and was said to occur on moist ground, deeply implanted. His plate shows three sclerotinioid apothecia which had been detached from their substrate. Later authors, Persoon (1801), Fries (1822), Saccardo (1889), Rehm (1887-96) also described it as occurring on the ground and it was not until Boudier (1905-10) identified a species growing on rhizomes of *Polygonatum multiflorum* as *Stromatinia rapulum* that this fungus was associated with any particular host plant.

The senior author has examined specimens of *S. rapulum* in the Persoon Herbarium, Rijksmuseum, Leiden, and in the herbarium of the Museum of Natural History, Paris. The latter specimens appear to be the ones from which the Boudier plates (1905-10) were made. These specimens were discussed by Drayton and Groves (1952).

As far as could be determined from an examination of the Bulliard and Boudier plates and the specimens in Paris and Leiden these could all be the same fungus. However, the difficulty of determining sclerotinioid species from apothecia alone is well known and the degree of host specificity has not been determined in this group and there is no real proof so far that Boudier's species on *Polygonatum* is the true *Peziza rapulum* Bull. It might be a similar species on a different host.

If we assume that the fungus on *Polygonatum* is correctly identified we still do not know whether or not it possesses a conidial state or has sclerotules in addition to the manteloid stroma. In other words we do not know whether or not the type species of *Stromatinia* possesses certain of the characters of the genus as emended and defined by Whetzel.

An apparently undescribed species of *Stromatinia* has been found occurring on rhizomes of *Sanguinaria* and investigations of this fungus provide additional evidence that *S. rapulum* sensu Boudier and *S. gladioli* (Drayt.) Whetz. are in fact congeneric. This fungus was first collected in May 1947 on rhizomes of *Sanguinaria canadensis* L. growing along the road between Old Chelsea and Tenaga, Quebec, a few miles north of Ottawa. It was collected again in very small quantity at the same location in May 1949, but in subsequent visits to this spot, the patch of *Sanguinaria* appeared to have died out and the fungus has not been collected here again. It would be impossible to say whether or not the disappearance of this colony of *Sanguinaria* was caused by this fungus. One other collection was made by Miss Sheila C. Hoare in May 1949 along the Sentier Champlain, Gatineau Park, Que. This collection consisted of two apothecia which were unfortunately detached from their substrate but were identified as this fungus from morphological and cultural characters. In spite of repeated search on *Sanguinaria* in other areas every spring the fungus has not been collected again and apparently occurs very rarely, at least in this district.

Single ascospore isolates of this fungus grown on potato dextrose agar at room temperature usually reach a diameter of 5–6 cm in five days although variations of 4.5–8.5 cm have been observed. The mycelium is fine, white and more or less appressed, and the hyphae septate, hyaline, branched, 1.75–4.0 μ wide. By the eighth day the colonies are about 9 cm in diam. and the sclerotules are beginning to develop causing the culture to appear somewhat pebbly. The immature sclerotules are at first whitish, appearing dark from the reverse side of the dish, but by ten days numerous typical black sclerotules are present. They are borne free on the now sparsely fluffy, white mycelium, rounded, globose to subglobose (0.1) 0.3–0.6 (1.0) mm in diam., occasionally coalescing or becoming slightly elongated up to 2 mm in length.

Numerous attempts to obtain apothecia in culture using spermatization technique and different temperature conditions have been unsuccessful, as also have been attempts to inoculate plants of *Sanguinaria* which have been transplanted to a garden or to pots in the greenhouse.

Nevertheless, because of the general lack of information about species of this group and because it does provide further evidence in support of Whetzel's concept of *Stromatinia*, it is thought desirable to describe this rare and interesting fungus.

Stromatinia sanguinariae sp. nov.

Apothecia solitaria vel subfasciculata, profunde cupulata, demum plus minusve expansa, 6–18 mm diametro, 3–10 mm alt., rufo-brunnea, glabra vel minute pubescentia, carnosa, longe stipitata; stipes 2–4 cm longus, 2–4 (4) mm crassus ad summas, aequalis vel versus basim attenuatus; asci cylindrico-clavati, longe stipitati, octospori, 125–160 \times 8.5–10.5 μ ; ascosporae ellipsoideae, hyalinae, unicellulares, (10) 11–13 (14) \times 5.5–6.5 (7.5) μ ; paraphyses hyalinae, filiformes; conidia nulla; spermatia hyalina, globosa, 2.5–3.5 μ diam.; stroma penuloidea, atra, subcuticulare; sclerotulae 0.1–1 mm diam., atrae, liberae in mycelio nascentes.

Habitat in rhizomatibus *Sanguinarias canadensis* L.

Apothecia single or slightly fasciculate, deep cup-shaped, goblet-shaped, thistle-tube-shaped, or infundibuliform, finally becoming more or less expanded, 6-18 mm in diameter, 3-10 mm deep, dark reddish brown, near "cinnamon brown" to "snuff brown" (Ridgway), fading slightly on drying, appearing glabrous when moist, slightly pubescent when dry, firm, fleshy, margin even, splitting slightly or becoming somewhat crenate in age, long stipitate; stipe 2-4 cm long, 2-3 (4) mm thick near the apex, nearly equal or tapering downward slightly, concolourous with the cup and becoming darker to nearly black at the base; hypothecium composed of a medullary zone and a clearly differentiated excipulum, the excipulum about 50-125 μ thick, pseudoparenchymatous, the cells about 10-20 μ in diam., the outer cells sometimes growing out to form short hairs, very irregular in shape, the walls slightly yellowish, the medullary zone composed of more or less loosely interwoven, hyaline hyphae, mostly 3-7 μ in diam., with an indistinct subhymenial zone of more closely interwoven hyphae about 2-3 μ in diam., in the stipe the excipular cells are thicker walled and darker

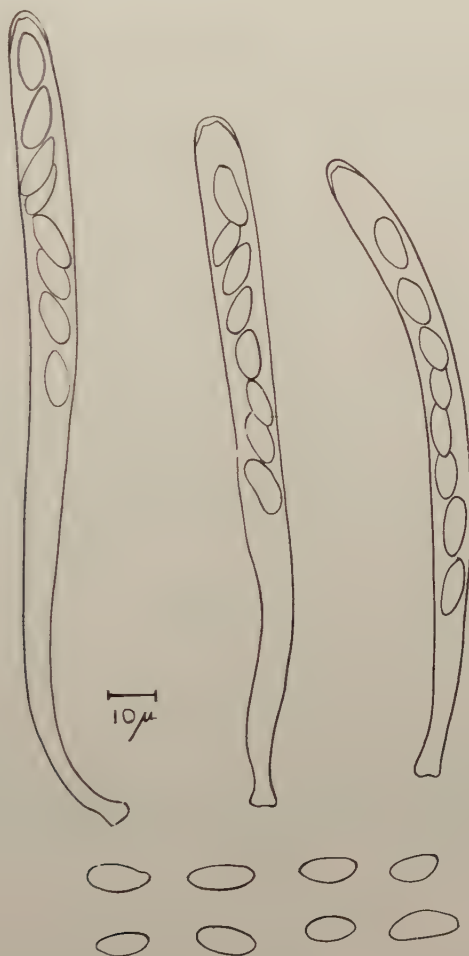


Figure 1

Stromatinia sanguinariae
Drawing of asci and ascospores.



Figure 2

Photograph of type collection of *Stromatinia sanguinariae*. $M = 0.75$

Figure 3

Culture of *Stromatinia sanguinariae* on potato dextrose agar. $M = 1$,

coloured and the medulla is more cellular in structure composed of chains of hyaline, more or less ellipsoid to quite irregular cells about $7-25 \times 5-14 \mu$ and with many intercellular spaces; asci cylindric-clavate, long stalked, eight spored, $(125) 130-150 (175) \times (8.5) 9-10.5 (11) \mu$; ascospores hyaline, one celled, ellipsoid or slightly unequal-sided, uniseriate, $(10) 11-13 (14) \times (5) 5.5-6.5 (7.5) \mu$; paraphyses hyaline, filiform, septate, unbranched, $1.5-2.5 \mu$ in diam., the tips clavate and slightly swollen up to $3-4 \mu$. Conidia lacking; spermatia hyaline, globose, $2.5-3.5 \mu$ in diam., borne on flask-shaped to subcylindrical phialides that may be borne singly on the mycelium or more frequently aggregated to form spermodochia

Stroma relatively thin, subcuticular, manteling the rhizome, composed of an outer, blackish rind consisting of one or two layers of almost isodiametric cells mostly $7-10 \mu$ in diam., and a medulla consisting of intricately interwoven, hyaline hyphae, $4-10 \mu$ in diam., embedded in a gelatinous matrix, more loosely interwoven in the central part with some interhyphal spaces, more compact beneath the rind; sclerotules more or less globose, $0.1-1$ mm in diam. or sometimes more elongated up to 2 mm in length, black, borne free on the mycelium, not firmly attached to the substrate, composed of very compactly interwoven, hyaline hyphae about $2.5-5 \mu$ in diam., embedded in a gelatinous matrix, the outer cells slightly swollen and strongly blackened forming a definite rind.

Host: apothecia arising from the manteloid stroma on rhizomes of *Sanguinaria canadensis* L.

Type: DAOM 23300. Road to Old Chelsea west of Tenaga, Quebec. Coll. Olga Prodan, F. L. Drayton, and J. W. Groves. May 15, 1947. Culture 323.

Specimens examined: DAOM 23301. Tenaga - Old Chelsea Road, Que., May 10, 1949, 1949. DAOM 23466. Sentier Champlain, Gatineau Park, Que., May 15, 1949.

DISCUSSION

The present concept of *Stromatinia* was established by Whetzel (1945) and the principal characters are lack of conidial state and presence of a manteloid stroma and sclerotules. This concept is based largely on *S. gladioli* (Drayt.) Whetz. which has been studied extensively in culture but whose apothecia have never been observed in nature. Only one of these characters, the manteloid stroma, is known with certainty to be possessed by the type species *S. rapulum* sensu Boudier occurring on rhizomes of *Polygonatum*. Certain other species such as *S. paridis* Boud. on rhizomes of *Paris* and *S. smilacinae* Durand on rhizomes of *Smilacina* have been found in nature and are obviously closely related to *S. rapulum*. They have not been studied in culture and the presence of sclerotules and absence of conidia have not been established except in *S. smilacinae* where Durand (1902) described small sclerotia that are undoubtedly sclerotules. *S. sanguinariae* is a species which in gross appearance morphology, and field characters is obviously close to *S. rapulum* and cultural studies have established that it does in fact lack conidia and possess sclerotules. It, therefore, provides evidence in support of the view that *S. rapulum* and *S. gladioli* are indeed congeneric and the genus *Stromatinia* Boud. emend. Whetzel is well founded.

ACKNOWLEDGEMENT

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ON THE PATHOGENICITY OF *TRICHODERMA VIRIDE* TO CITRUS FRUITS

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ABSTRACT

Various problems concerning the pathogenicity of *Trichoderma viride* Pers. ex Fries to citrus fruits have been studied and discussed.

Comparative inoculations. The characteristics of rots induced in Shamouti oranges and Eureka lemons by *T. viride* and some other fungi producing similar types of decay make it possible to determine the causal agents, thus eliminating the need for preparing isolations.

Susceptibility of citrus varieties. Eureka lemons inoculated with *T. viride* have the shortest incubation period and fastest rate of development; next are Shamouti oranges and Marsh Seedless grapefruits, and last Valencia oranges, which show some resistance to fungal infection.

Inoculations at different temperatures. Optimum temperature for infections is about 25° C; at 5° C and 36°C no decay develops.

Inoculations with mixtures of fungi. The rate of decay produced by inoculations with mixtures of *T. viride* and other fungi pathogenic to citrus was usually (though not always) determined by the component which induced the more rapid decay.

Inoculations of fruits on the tree. Of the methods used, only "window" inoculations gave positive results. All affected fruits dropped from the tree at first appearance of decay.

Inoculations by contact. Attempts to induce rot in sound, unwounded citrus fruits by contact with decayed fruit, gave negative results.

Inoculation of different parts of the fruit. Decay resulted from all inoculations at the base of the fruit. In case of stem-end cut inoculations the results were negative with lemons and Valencias, and only partial success was obtained with Shamouti oranges. Attempts to infect the fruit through the sepals were unsuccessful.

Modes of infection. When dry spores or suspension in water were used as inoculum, infection was produced only by pricking through the oil glands—and even in this case success was only partial. Inoculations by scratching or by pricking between the oil glands gave negative results. The use of essential oil as a medium for spore suspensions increased the infection rate, and ensured success with all inoculation methods that failed in case of dry spores or watery suspension. The percentage of infection was found to increase with the depth of pricking and the interval between pricking and inoculation. The inoculation experiments with a spore suspension in irradiated essential oil (containing peroxides) failed even in the case of "window" inoculation. It was found that essential oils (particularly irradiated oil) have some phytotoxic properties and, when applied to the rind, they cause oleocellosis which is very often followed by lowered resistance to infection by some fungi other than *Trichoderma* and by the development of rots. The causal agents of these rots are usually *Alternaria citri* and *Colletotrichum gloeosporioides* which are generally associated with latent infections in the rind of citrus fruits.

INTRODUCTION

In spite of the extensive literature on *Trichoderma viride* Pers. ex Fries, as a producer of antibiotics and as a component of soil-and air-microflora, not enough attention has been paid to this fungus as a causal agent of citrus fruit rots.

Isolations from rotted citrus fruit carried out at the Agricultural Research Station Rehovot, during several years, as well as inspections of the fruit after its arrival on the market, revealed that the incidence of rot caused by *Trichoderma* is much higher than previously thought, amounting, during the second half of the season, to 10–20% or even more of the decayed fruits, particularly stored lemons. Thus, it appears that the role of *Trichoderma* as an agent of fungal decay of citrus fruit has been underestimated; it seems that due to some similarities, the rots caused by *Trichoderma* were included in other types of decay caused by different fungi.

In this paper the pathogenicity of *Trichoderma* to citrus fruit is dealt with. Among the topics discussed are: comparative inoculations with *Trichoderma* and other fungi, relative susceptibility of various citrus varieties, inoculations with mixtures of fungi and modes of infection.

MATERIALS AND METHODS

Eureka lemons were generally used in inoculation experiments for the following reasons: (1) *Trichoderma* attacks lemons most often, (2) develops rapidly in them, and particularly, (3) the oil glands in the peel of lemons are widely interspaced and this is of importance in experiments concerning modes of infection where inoculations into the tissue between oil glands are to be made.

In some experiments other citrus varieties were also used. In general one of the two following inoculation methods was used, according to the purpose of the experiment:

1. After surface sterilization with ethanol, a "window" of 3 × 5 mm was opened in the peel, the inoculum inserted and the spot sealed with paraffin.
2. The peel was surface-sterilized, a drop of spore suspension placed on it and inoculation affected by pricking the proper tissue six to ten times to the required depth using a No. 0 entomological needle. The infection site was sealed with a small glass "bell" by the "micro-moist chamber" method (Gutter 1955).

A spore suspension, containing from 5 to 20 million spores per cc, from a culture of *Trichoderma* grown on 2% potato-dextrose agar was used as inoculum. The culture was originally isolated from the crown of a sweetlime rootstock. Generally ten fruits were inoculated for each treatment. The inoculated fruits were incubated at 23° to 25° C. At the end of each experiment reisolations were made from a number of inoculated fruits.

Controls underwent the same treatment as did the infected fruits, except that sterile water was substituted for the spore suspension.

RESULTS

Comparative Inoculations with Different Fungi

Shamouti oranges and Eureka lemons were "window" inoculated with *Trichoderma* and six other fungi causing similar rots and the types of decay compared. Pieces of agar with mycelium from three-day-old cultures served as inoculum. The seven fungi inoculated were: *Trichoderma viride*, *Diplodia natalensis*, *Phytophthora citrophthora*, *Botrytis cinerea*, *Colletotrichum gloeosporioides*, *Fusarium* sp. and *Alternaria* sp.

In *Trichoderma* the incubation period is 4 to 5 days. Rate of development somewhat slower in lemons than in oranges. Rot spreads evenly or sometimes along segments. Decay at the beginning firm to pliable, remains pliable. Colour of fruit unchanged for some time, then later turns to brown in oranges and beige, beige-brown, and at last dark brown in lemons. Albedo becomes brownish in Shamoutis and beige to beige-brown, "watersoaked" in lemons. Decay is accompanied by browning of the veins (Figure 1). There is no change in colour of the pulp. Fruits decayed by *Trichoderma* have a strong characteristic coconut-like odour. After some time a mycelium with green, blue-green or yellow-green masses of spores is formed on the fruit and sometimes in its core.

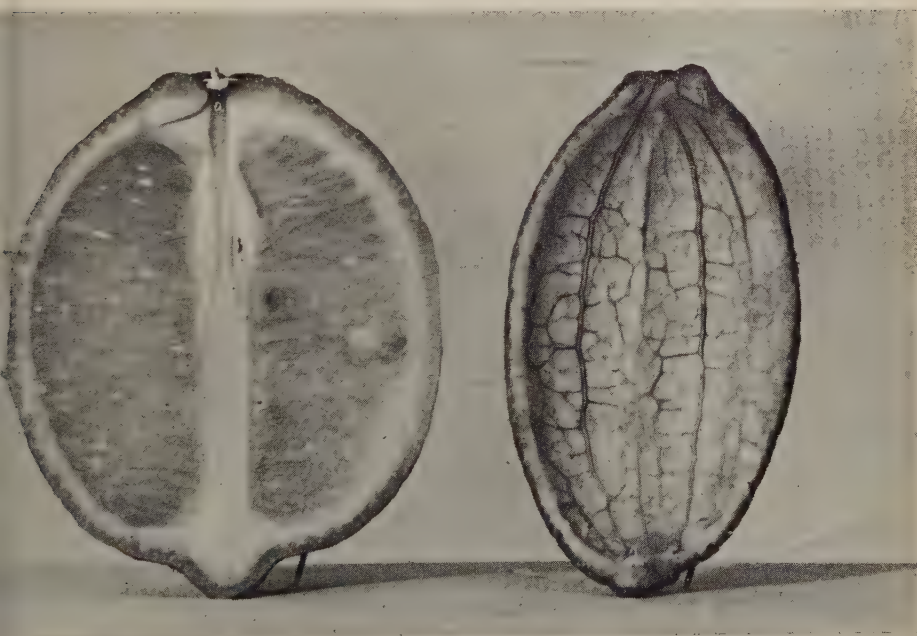


Figure 1

Browning of veins in a Eureka lemon decayed by *Trichoderma viride*

On the basis of a comparison of the above description with that of decay caused by the other six fungi, a differentiation between the various types of decay may be made along the following lines:

The rots caused by *Colletotrichum*, *Alternaria* and *Fusarium* differ from the other four by their long incubation period (2 to 4 weeks), by their slow rate of development and by the fact that they are often an internal rot.

The other four types of decay, caused by *Trichoderma*, *Diplodia*, *Phytophthora* and *Botrytis* have a short incubation period (only several days) and a fast rate of development. Between these four, the rot caused by *Botrytis* is soft from the beginning and has a characteristic violet taint. The other three show no change in colour at the beginning and are pliable in texture; but the *Diplodia*-rot softens soon and the peel becomes gray. The *Trichoderma*- and *Phytophthora*-rots both remain pliable but the brown colour is deeper in the case of *Trichoderma*. These four types of decay may also be differentiated by their odours: in *Trichoderma* a coconut-like odour; in *Diplodia* a peculiar, stringent odour; in *Phytophthora* an aromatic one, characteristic only to *Phytophthora*-rot and in *Botrytis* an odour resembling that of forest mushrooms.

The above differentiation makes it possible to determine the causal agents of decayed fruits without the necessity of preparing isolations.

Susceptibility of Citrus Varieties to Trichoderma

In order to assay the susceptibility of different citrus varieties to *Trichoderma*, Eureka lemons, Marsh Seedless grapefruits, Shamouti and Valencia oranges were "window inoculated" with the same spore suspension and incubated at six different temperatures (ranging from 5° to 35°C).

The shortest incubation period was found with lemons, which correlates with their liability to *Trichoderma*-rot; the incubation period was somewhat longer with grapefruits and Shamoutis and longest with Valencias, which show, apparently, some resistance to infection.

The same order was valid at all temperatures tested.

Inoculations at Different Temperatures

Inoculations of different citrus varieties with spore suspensions of *Trichoderma* carried out at various temperatures ranging from 5° to 36° C have shown that the optimum for infection is at about 25°C. This may explain the occurrence of *Trichoderma*-rot during the second half of the season, when high temperatures are prevalent. At 28.5°C the incubation period was still somewhat shorter, but symptoms of decay, damage and inhibition were found. Temperatures of 5° and 36° C may be accepted as minimum and maximum, as no decay symptoms developed at these temperatures during the several weeks' observation period. Nevertheless the fungus remains viable, since all the fruits decayed after subsequent transfer to 25°C.

Inoculations with mixtures of fungi

In nature a fruit rot is often caused not by a single microorganism, but by a mixture of two or more fungi.

To study the type of decay caused by mixtures of *Trichoderma* and other fungi, its rate of development and possible phenomenon of synergism or antagonism, mixed inoculations were carried out on lemons and Shamouti oranges. The fruits were "window" inoculated with spore suspensions (equal density) of *Trichoderma viride*, *Penicillium digitatum* and *P. italicum* and mixtures of these suspensions in every possible combination. Also, inoculations were carried out with the following fungi: *Diplodia natalensis*, *Phytophthora* sp., *Oospora citri-aurantii* (*Geotrichum candidum*), *Colletotrichum gloeosporioides* and *Alternaria citri*, and with mixtures of *Trichoderma* and each of these. The diameter of the infected area was measured during the observation period, and reisolutions from the same area carried out.

The results have shown that, in general, the rate of development of rots caused by a mixture of two fungi is close to that of the faster component of the mixture. The exception is the inoculation with a mixture of *Diplodia* and *Trichoderma*: in this case the rate of development of the rot resembled that of *Trichoderma*, in spite of the fact that *Diplodia* is the faster growing component.

The type of decay caused by the mixture of *Oospora* and *Trichoderma* seems to be the resultant of the shorter incubation period of *Oospora* (soft, colourless decay near the inoculation site) and the faster rate of development of *Trichoderma* (surrounding brown, pliable rot).

The incubation period was always shorter and the rate of development faster in lemons than in oranges.

It is obvious that several factors may influence the results of mixed inoculations, but these have not yet been studied independently.

Inoculations of fruits on the tree

In order to study the effect of *Trichoderma*-inoculations of fruits while still on the tree, green and yellow (or orange) lemons and Shamouti oranges were inoculated with a spore suspension of *Trichoderma* using various methods of inoculation. Observation lasted several weeks.

Of all the methods used, only the "window" inoculations were successful and resulted in all infected fruits dropping off the tree close to the time of appearance of the first symptoms of decay (7 to 10 days after inoculation).

It may be assumed that the changes caused by the growing fungus inside the fruit are responsible for the observed "forced yellowing" of the tissue round the inoculation point and the apparent formation of an abscission layer, which caused the fruit to drop off, since in the controls the yellowing was slow and the fruits did not drop, even after the severe "window" injury.

A similar phenomenon of a drop of oranges inoculated on the tree with *Penicillium digitatum* was noticed by Ben-Ami (1937).

Other methods of inoculation failed and the inoculation site was marked by a reddening of the adjacent tissue.

Inoculations by contact

To answer the question whether *Trichoderma* is transmissible by contact, sound, surface-sterilized lemons, Shamoutis and Valencias were brought into contact with *Trichoderma*-decayed fruits and kept, wrapped or unwrapped, at a high relative humidity.

Negative results were obtained, except in cases where the exuding juice of the adjacent decayed fruits caused damage to the peel of the sound fruit.

Thus, *Trichoderma* seems to be unable to spread from one fruit to another, provided no damage has been previously caused to the peel of the fruit.

Inoculations of different parts of the fruit

In looking for possible sites of infection, other than the peel, inoculations of different parts of the fruit were carried out.

Lemons and Shamouti oranges were debuttoned, surface-sterilized and inoculated at their base, i.e., the place where the fruit is attached to the stem.

In all cases positive results were obtained, this method resembling somewhat the "window" inoculation.

Next, inoculations through the sepals of the fruit or the stem-end cut were carried out on lemons, Valencias and Shamoutis, all giving negative results. Only stem-end cut inoculations of Shamoutis were partially successful, the percentage of rotted fruits being somewhat greater with fruits inoculated one week after picking than with those inoculated on the day of picking.

Modes of infection

Based on the results of several more detailed experiments carried out on lemons (and in some instances also on Valencias and Shamoutis), the influence of the factors of (1) inoculation site, (2) medium of inoculum, (3) depth of inoculation, is dealt with.

When dry spores of *Trichoderma* or their suspension in water were used as inoculum, infection could be produced only by pricking through the oil glands, and even then success was sometimes only partial. Inoculations by scratching the peel or by pricking into the tissue between the oil glands gave negative results. If, however, essential oil was used as a medium for spore suspensions (thus, imitating conditions found in nature, when as a result of an occasional bruising of the fruit, some of the spores may become suspended in the liberated essential oil), then the infection rate was increased and success ensured with all inoculation methods that failed, when

dry spores or aqueous suspension was used. Thus, essential oil enhances infection.

But the same essential oil and particularly its main component, d-limonene, when outside its natural container—the oil gland, oxidizes on coming into contact with light and air, and the resulting peroxides exert an antimicrobial activity (Zukerman 1951; Zukerman and Nadel-Schiffman 1956).

Experiments with various inoculation methods, in which spore suspensions of *Trichoderma* in both non-irradiated and irradiated (cont. 4.8% peroxides after 4 hours' exposure to sunlight) essential oil were used, have shown that all inoculations with non-irradiated oil were successful, while those with irradiated oil gave negative results, even in the case of the severe "window" inoculation.

Several other experiments were also carried out in which spore suspensions in water or non-irradiated essential oil were used to inoculate lemons by pricking into the oil glands or the tissue between them, to various depths. The fruits, both green and yellow, were inoculated on the day of picking or after a delay of four weeks.

The experiments have shown that the deeper the pricking, the greater the success of the inoculation and the shorter the incubation period. Generally, the probability of success is greater with inoculations through the oil glands than between them; but the very shallow inoculations into the oil gland (which do not pass its walls) failed in every case, while same shallow inoculations into the tissue between the oil glands were sometimes (when spores were suspended in oil or when inoculation was carried out after a delay) successful. The experiments have shown again that the possibility of success in inoculations with a suspension in essential oil is always greater than with a suspension in water. Also the percentage of successful inoculations is always greater, if there is a delay before inoculation, than if the fruit is inoculated on the day of picking.

No striking differences were found, when green or yellow fruits were inoculated.

An additional observation should be mentioned: if several oil glands of a citrus fruit are bruised, the liberated essential oil causes a blemish, called oleocellosis, where the tissue between the oil glands is sunken and often turns brown. Similar oleocellosis may be invoked artificially by applying the essential oil to the peel. Inoculations with *Trichoderma* through such artificial blemishes gave negative results; but very often the blemished spot turned brown after some time, then black, and later a pliable rot appeared, from which in most cases *Alternaria* and *Colletotrichum* were isolated, fungi which are often found on the peel in the form of a latent infection.

DISCUSSION AND CONCLUSIONS

It may be concluded from the results of the experiments that *Trichoderma* is a wound parasite similar to *Penicillium digitatum*. Thus, presumably, all preventive methods, effective in the case of *P. digitatum*, will also give good results against *Trichoderma*.

Apart from being a wound-parasite, *Trichoderma* is sometimes able to infect

citrus fruits through the so-called devitalized stem-end (see Batchelor and Webber 1948, p. 513).

Experiments have shown that the use of *Trichoderma*-spores suspended in essential oil enhances the infection as compared to inoculations with dry spores or suspension in water. This correlates with another observation, that inoculations through the oil glands are more successful than into the tissue between the oil glands. However, this essential oil on coming into contact with light and air undergoes oxidation and the resultant peroxides possess antimicrobial properties. Subject to further experimentation, one may assume that in nature conditions favour infection if the time elapsing between the bruising of the fruit and the actual inoculation (when spores come into contact with the injured peel) is short. But if the time is long enough to allow oxidation of the liberated essential oil, then the active limonene-peroxides may kill or inhibit the fungus, thus serving as a defense mechanism.

The essential oil, particularly the irradiated one, has apparently also some phytotoxic properties, since in addition to causing oleocellosis-type blemishes, it brings about some drastic changes in the tissue of the fruit, which result in blackening of the tissue and finally in development of *Alternaria*- and *Colletotrichum*-types of decay. This may indicate an oil-induced breakdown in the resistance of the fruit, since the above fungi are generally found in the peel in the stage of a latent infection and the decay caused by them appears under normal conditions only after a prolonged storage of several weeks.

Therefore, the relationship between the essential oil, the fruit and the pathogen is of great importance in understanding the mechanism of infection of citrus fruits by fungi and deserves further study.

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SUR UNE FORME EUROPEENNE ET PLEOPHAGE DE *PUCCINIA AGROPYRI* ELLIS ET EVERHART

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Grignon

ABSTRACT

Etude de la pléophagie de *Puccinia agropyri* Ellis et Everhart (forme européenne) [= *Puccinia hordei-maritimi* Guyot et Massenot] en région périméditerranéenne.

Puccinia agropyri a été décrit en 1892, aux Etats-Unis, par Ellis et Everhart d'après un exemplaire prélevé sur *Agropyrum glaucum** dans le Montana; la diagnose originale fait état de téléutospores particulièrement longues et relativement grêles puisque mesurant $60-75 \times 20-25 \mu$. Depuis, il a été reconnu que *P. agropyri* vit surtout, en Amérique septentrionale, sur *Agropyrum smithii*, hôte sur lequel ses probasides apparaissent singulièrement élancées et minces puisque mesurant (d'après nos déterminations biométriques faites sur des échantillons en provenance du Colorado et du Montana):

L.** $50-75$ ($40-80$) \times l.s. $17-20$ ($15-23$) \times l.i. $11-15$ ($10-20$),
en moyenne L. $55-65 \times$ l.s. $18-19 \times$ l.i. $12-14 \mu$

$$\left[\text{rapport} \quad \frac{\text{longueur}}{\text{largeur inf.}} = 4 \text{ à } 5 \right]$$

[épaisseur de l'épispore au sommet: $6-8$ ($4-10$) μ]

En Europe, il existe une forme urédinée homologue du *P. agropyri* nord-américain. Dès 1882, Cornu indique qu'en France méridionale, un *Uredo* sur *Agropyrum* se rencontre en compagnie d'un *Aecidium* sur *Clematis*; en 1893, Lagerheim fait une observation semblable dans le duché de Bade. En 1892, P. Dietel obtient des spermogonies et écidies sur *Clematis vitalba* à partir de téléutospores prélevées sur *Agropyrum glaucum* près Bozen (Tyrol); il considère qu'il s'agit de *P. agropyri* E. et E.

* J. C. Arthur (1934) considère qu'il s'agissait, en fait, d'*Agropyrum smithii*.

** Abbreviations: L.=longueur; l.s.=largeur supérieure; l.i.=largeur inférieure; toutes les dimensions en μ .

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En 1948, nous avons obtenu, à partir d'écidies recueillies sur *Clematis vitalba* à Vence (Alpes-Maritimes), une infection positive sur *Agropyrum campestre* (tandis que de nombreuses autres Graminées demeuraient indemnes); le champignon a été rapporté par nous à *P. agropyri*. En 1952, nous avons obtenu, à partir de téléutospores recueillies sur *Agropyrum campestre* aux environs de Valréas (Vaucluse), une infection positive sur *Clematis flammula* (spermogonies seulement), négative par contre sur *C. vitalba*; le champignon a été rapporté par nous à *P. agropyri*. En 1957, nous avons obtenu, à partir de téléutospores recueillies sur un *Agropyrum* non fructifié et à feuilles glauques (? *campestre* ou *glaucum*) aux environs de Pont-Saint-Esprit (Gard), une infection positive sur *Clematis vitalba*; le champignon est considéré par nous comme appartenant à *P. agropyri*.

A plusieurs reprises, d'autre part, nous avons constaté le voisinage étroit, sur le terrain, de *P. agropyri* sur *Agropyrum campestre* et d'écidies sur *Clematis vitalba*.

Le champignon qui vit en Europe sur le couple d'hôtes *Agropyrum* (*campestre* surtout) — *Clematis* (*flammula*, *recta* et *vitalba*) est proche, dans sa structure, du champignon (*P. agropyri* E. et E.) qui vit, en Amérique septentrionale, sur le couple d'hôtes *Agropyrum* (*smithii*) — *Clematis* (plur.spec.); il s'en distigue, toutefois, par ses téléutospores un peu moins longues et un peu plus larges. Compte tenu à la fois des obtentions expérimentales et des récoltes faites en nature, cette forme européenne de *P. agropyri* E. et E. répond à la formule biométrique suivante*:

$$\begin{array}{l} \text{L. } 38-71 \text{ (30-84)} \times \text{l.s. } 13-24 \text{ (10-30)} \times \text{l.i. } 10-18 \text{ (9-24),} \\ \text{en moyenne L. } 46-62 \times \text{l.s. } 15-21 \times \text{l.i. } 13-17\mu \end{array}$$

$$\left[\text{rapport } \frac{\text{longueur}}{\text{largeur inf.}} = 3 \text{ à } 4. \text{ exceptionnellement } 4,3 \right]$$

$$\left[\text{épaisseur de l'épispore au sommet: } 3-7 \text{ (2-9)}\mu \right]$$

Si on s'en tient, pour la caractérisation morphologique de l'espèce *P. agropyri* (forme européenne), aux seules récoltes s'étant montrées en liaison expérimentale avec *Clematis flammula*, *recta* ou *vitalba*, on obtient la formule biométrique suivante:

$$\begin{array}{l} \text{L. } 38-65 \text{ (33-80)} \times \text{l.s. } 13-20 \text{ (10-25)} \times \text{l.i. } 12-18 \text{ (9-21),} \\ \text{en moyenne L. } 46-55 \times \text{l.s. } 15-18 \times \text{l.i. } 13-16\mu \end{array}$$

$$\left[\text{rapport } \frac{\text{longueur}}{\text{largeur inf.}} = 3 \text{ à } 4 \right]$$

L'*Uredo* de *P. agropyri* (forme européenne) peut être ainsi caractérisé (d'après les observations faites sur les récoltes en nature du parasite):

* Ces conclusions sont en accord avec les observations faites par divers mycologues:

P. et H. Sydow, dans leur Monographie des Urédinées, caractérisent *P. agropyri* (sur *Agropyrum glaucum* et *juncum* en Europe) par les dimensions suivantes des téléutospores: $40-80 \times 11-22\mu$. Massalongo a décrit en 1900, sur *Agropyrum glaucum* près Vérone (Italie), *P. agropyri* var. *europaea*, dont les probasides mesurent $67-70 \times 12-17\mu$.

Urédosores brun-orangés à brun-ferrugineux, pulvérulents, petits, isolés ou épars en plus ou moins grand nombre sur les deux faces de la feuille, parfois aussi disposés en séries linéaires interrompues dans les espaces internerviaires des limbes, également sur les gaines foliaires, le chaume, le rachis ou les glumes.

Urédospores subglobuleuses ou ellipsoïdes, $23-31$ ($20-32$) ($\rightarrow 38$) $\times 20-27$ ($18-31$), moy. $24-30$ ($\rightarrow 33$) $\times 21-26\mu$, à épispore d'abord subhyalin ou flavescent, ensuite jaunâtre ou brunâtre et enfin brun-châtain, épais de $1-2$ ($\rightarrow 2.5$ et même 3μ), finement et assez densément échinulé et pourvu de $5-8$ ($3-10$) pores germinatifs épars.

Il importe maintenant d'envisager le problème de la spécialisation parasitaire chez *Puccinia agropyri* (forme européenne).

Jusqu'ici, ce champignon était considéré comme vivant seulement, en nature, sur un petit nombre d'espèces d'*Agropyrum* (*A. campestre*, *glaucum* et *intermedium* le plus souvent, *A. junceum* parfois); nous proposons d'ajouter, aux hôtes possibles de *P. agropyri*, *Agropyrum acutum* et *repens*, sur lesquels nous avons remarqué la présence du parasite en un petit nombre de localités périméditerranéennes*.

Parmi nos récoltes personnelles, citons entre autres les suivantes :

a) sur *Agropyrum acutum*. FRANCE, sur la côte entre Sainte-Maxime et Saint-Aygulf (Var); sub nom. *P. rubigo-vera* in *Uredineana*, **1**, p. 48.

b) sur *Agropyrum junceum*. FRANCE, sables littoraux à Beauvallon près Sainte-Maxime (Var); sub nom. *P. rubigo-vera* in *Uredineana*, **1**, p. 47

c) sur *Agropyrum repens*. ESPAGNE, environs de Tarifa près Algésiras (*in herb.*). MAROC, bords de l'Oued Réraia près Asni (Grand Atlas), 1100 m alt.; sub nom. *P. aff. agropyri* in A. L. Guyot et G. Malençon, Urédinées du Maroc, **1**, p. 29. TUNISIE, Menzel Tenine (presqu'île du Cap Bon); sub nom. *P. rubigo-vera* in *Uredineana*, **2**, p. 48.

Il pouvait paraître également intéressant d'essayer, par voie expérimentale, de faire vivre *P. agropyri* sur d'autres supports que ceux jusqu'alors reconnus dans la nature; c'est ce que nous avons tenté à plusieurs reprises :

a) Des urédospores, prélevées sur *Agropyrum campestre* au voisinage immédiat de touffes de *Clematis recta* porteuses d'écidies près Montpellier (Hérault), le 10 mai 1949, ont permis, par contamination artificielle, l'obtention d'urédos sur *Agropyrum caninum* et *repens* et *Hordeum maritimum*.

b) Des urédospores, prélevées sur *Agropyrum campestre* au voisinage immédiat de touffes de *Clematis vitalba* porteuses d'écidies près Vence (Alpes-Maritimes), le 15 mai 1949, ont permis, par contamination artificielle, l'obtention d'urédos sur *Elymus arenarius*.

c) Des urédospores, prélevées sur *Agropyrum campestre* croissant parmi les touffes de *Clematis flammula* porteuses d'écidies à Hyères (Var), le 18 mai 1953, ont permis, par contamination artificielle, l'obtention d'urédos sur *Aegilops ovata* et *triuncialis* (sur taches chlorotiques très marquées), *Agropyrum caninum* et *repens*, *Elymus hordeiformis* et *virginicus*, *Hordeum maritimum*, *Secale cereale* (quelques sores malformés sur taches chlorotiques) et *S. montanum*.

* Notons, par ailleurs, que *P. agropyri* est cité sur *Agropyrum caninum* en Espagne (Val d'Aran) par R. G. Fragoso—1927; sur *A. junceum* en Espagne (Lugo) par R. G. Fragoso—1916 et en Corse (Ajaccio) par E. Mayor et Ch. Terrier—1957; sur *A. pycnanthum* en Grèce (Attique) par R. Maire et J. Politis—1940; sur *A. repens* en Autriche (Tirol) par P. Magnus—1926 et en Corse (Ajaccio) par E. Mayor et Ch. Terrier—1957.

d) Des urédospores, prélevées sur *Agropyrum* (? *campestre*) croissant parmi des touffes de *Clematis flammula* porteuses d'écidies près de Montpellier (Hérault), le 20 mai 1953, ont permis, par contamination artificielle, l'obtention d'urédos sur *Aegilops ovata* (sores petits sur taches nécrotiques), *Agropyrum caninum* et *cristatum*, *Hordeum murinum* (sores se nécrosant rapidement), *Secale cereale* et *montanum*.

e) Des téléutospores, recueillies sur un *Agropyrum* non fructifié et à feuilles glauques (? *campestre* ou *glaucum*) aux environs de Pont-Saint-Esprit (Gard), le 18 juin 1956, ont permis, après hibernation au-dehors, une infection printanière massive de *Clematis vitalba*; les écidies ainsi obtenues sur Clématite ont procuré, par contamination artificielle, une attaque nette du Seigle et d'*Elymus caput-medusae* (avec formation rapide de téléutosomes).

f) Des urédospores recueillies sur *Agropyrum* (? *campestre*) près Montpellier (Hérault), le 28 mai 1958, ont permis, par contamination artificielle, l'obtention d'urédos abondants sur *Agropyrum orientale*, *Elymus caput-medusae* et *Hordeum maritimum*, rares sur *Agropyrum campestre* et *repens*, *Elymus hordeiformis* et *Hordeum jubatum*.

g) Des urédospores recueillies sur *Agropyrum* aff. *campestre* à proximité de touffes de *Clematis flammula* porteuses d'écidies près Montpellier (Hérault), le 11 juin 1958, ont permis, par contamination artificielle, l'obtention d'urédos abondants sur *Agropyrum campestre*, *Elymus caput-medusae* et *Hordeum jubatum*, assez abondants sur *Agropyrum caninum* et peu abondants sur *Aegilops ovata*.

Au total, le spectre phytoparasitaire de *Puccinia agropyri* E. et E. (forme européenne) se dégage comme suit de nos tentatives de contamination expérimentale:

Très sensibles: *Agropyrum (orientale)*
Elymus (caput-medusae)
Hordeum (maritimum).

Plus ou moins sensibles: *Aegilops (ovata et triuncialis)*
Agropyrum (campestre, caninum, cristatum et repens)
Elymus (arenarius, hordeiformis et virginicus)
Hordeum (jubatum)
Secale (cereale et montanum)

Peu sensible : *Hordeum (murinum)*
 Réfractaire : *Triticum (sp.)*

Ce spectre phytoparasitaire s'identifie, dans ses traits essentiels, à celui dont témoigne l'espèce expérimentale *Puccinia hordei-maritimi*, créée par A. L. Guyot et M. Massenot en 1948 et étudiée en serre à Grignon, depuis cette date, à partir de formations écidienne récoltées sur *Clematis flammula*, *recta* et *vitalba* en France méridionale; les hôtes reconnus à *P. hordei-maritimi*, par voie expérimentale, se classent, en effet, comme suit:

Très sensibles: *Aegilops (ovata, triaristata et triuncialis)*
Hordeum (maritimum)
Secale (cereale et montanum)

Plus ou moins sensibles: *Agropyrum (caninum, junceum et pungens)*
Elymus (europaeus, sabulosus et virginicus)
Haynaldia (villosa)

Peu sensibles: *Agropyrum (repens)*
Elymus (arenarius et canadensis)
Hordeum (murinum)

Réfractaires: *Bromus* (toutes espèces essayées)
Hordeum (secalinum et vulgare)
Triticum (vulgare)

D'autre part, les caractéristiques morphologiques de *P. Hordei-maritimi* sont très proches de celles de *P. agropyri* (forme européenne), tant au stade urédo qu'au stade téléuto; l'étude biométrique des probasides de *P. hordei-maritimi*, considérées sur l'ensemble de ses hôtes, permet d'attribuer à celles-ci les dimensions suivantes:

L.28-65 (25-75) \times l.s.13-22 (10-27) \times l.i.12-20 (10-24),
 en moyenne L.35-55 \times l.s.15-20 \times l.i.13-17 μ

L'Uredo *P. hordei-maritimi* peut être ainsi caractérisé (d'après les observations faites sur plantules artificiellement contaminées en serre):

Urédosores très petits, jaune orangé, épars ou plus ou moins groupés, évoluant très vite en téléutosores.

Urédospores subglobuleuses ou ellipsoïdes, 24-28 (22-34) \times 21-24 (20-26) μ , à membrane mince (1 à 1.5, rarement \rightarrow 2 μ), hyaline, flavescente ou jaune-brunâtre dilué, finement échinulée et percée de 7-9 (5-10) pores germinatifs épars.

Si on observe, enfin, que l'hôte écidien est représenté, pour l'une comme pour l'autre des deux espèces précitées, par l'ensemble des espèces indigènes de Clématite (*Clematis flammula*, *recta* et *vitalba*), il semble bien que rien n'interdise de conclure à l'identité tant morphologique que biologique de ces deux formes fongiques.

Sur le plan biologique, il importe de noter une certaine différence de comportement dans les conditions de succession des stades évolutifs du champignon chez ces deux formes de Rouille: persistance parfois (mais non toujours) prolongée de l'urédo chez *P. agropyri* évoluant spontanément sur *Agropyrum*, urédo éphémère (parfois même avorté) et apparition souvent (mais non toujours) rapide du téléuto sur les jeunes plantules contaminées en serre à partir des écidies de *P. hordei-maritimi* recueillies en nature sur *Clematis**.

Ont été également décrits, comme possédant une phase écidienne sur *Clematis* (en liaison avec des espèces des genres *Aegilops*, *Agropyrum*, *Secale* et *Triticum*):

a) *Puccinia persistens* Plowr.f.sp. *clematidis-agropyri* Guyot et Massenot 1948

Obtenue en serre à Grignon en 1947, sur *Agropyrum repens*, à partir d'écidies recueillies sur *Clematis vitalba* à Hyères (Var), cette Rouille expérimentale a montré (sur plantules artificiellement contaminées) des téléutospores mesurant L.36-46 (27-59) \times l.s.15-18 (10-22) \times l.i.13-17 (11-22), en moyenne L.38-42 \times l.s.17-17.5 \times l.i.14.7-15.8 μ .

Compte-tenu des conditions particulières d'obtention de cette forme urédinienne et de sa structure, ainsi que d'une singularité biologique constatée à son sujet (passage immédiat au stade téléuto sans urédo différencié), nous pensons aujourd'hui que cette Rouille ne peut être distinguée de *P. hordei-maritimi*.

b) Une Rouille étudiée par O. Treboux en 1912 en Russie méridionale: infection violente (urédos et téléutos formés) d'*Agropyrum repens* à l'aide d'écidies prélevées sur *Clematis pseudoflammula*.

L'auteur rattache cette Rouille à *P. agropyri* E. et E., mais n'en donne aucune description.

* Notons d'ailleurs, d'une façon générale, que la rapidité de passage de l'urédo au téléuto, comme aussi le nombre des hôtes qui se révèlent réceptifs ainsi que l'intensité d'attaque de ceux-ci, sont, chez ces deux champignons, nettement plus grands à partir des échantillons liés à une phase écidienne qu'à partir de ceux liés à un stade urédo.

- c) Une Rouille étudiée par R. Maire en 1914 en Afrique septentrionale: très abondante sur *Agropyrum repens* dans tout le Tell algérien et produisant ses écidies sur *Clematis flammula* (à plusieurs reprises ont été constatées, dans des conditions d'infection naturelle, l'infection massive, d'une part de *Clematis* au contact d'*Agropyrum* porteurs de téléutospores, d'autre part d'*Agropyrum* au contact de *Clematis* couverts d'écidies).
Aucune description n'a été donnée de cette Rouille par l'auteur, qui la rattache à *P. agropyri* E. et E.
- d) Une Rouille étudiée par G. Dupias en 1948 et 1952 dans le Midi de la France (région de Toulouse): infection violente (urédos et téléutos formés) d'*Aegilops ovata* et *Secale cereale* à l'aide d'écidies prélevées sur *Clematis vitalba*.
En 1953 (*Uredineana*, 4, p. 306), nous avons exprimé l'opinion que cette Rouille, que son créateur a nommé *P. clematidis-secalis* et qui n'a pu être transmise à *Agropyrum* (*campestre* et *repens*) et à *Triticum* (*vulgare*), ne saurait être distinguée morphologiquement de *P. hordei-maritimi*.
- e) Une Rouille étudiée par C. Sibilia en 1956 en Italie: à partir d'écidies prélevées sur *Clematis vitalba*, résultats nettement positifs sur Blé, moins significatifs sur Orge, nuls sur Seigle et Avoine.
Aucune description n'a été donnée de cette Rouille par l'auteur.

Pour notre part, nous sommes convaincus que le champignon que nous étudions à Grignon depuis 1948, sous le nom de *Puccinia hordei-maritimi* Guyot et Massenot, n'est que le faciès évolutif, sur jeunes plantules artificiellement contaminées en serre à partir du stade écidien sur *Clematis*, du parasite (*Puccinia agropyri* E. et E., forme européenne) qui évolue, en nature, sur les *Agropyrum* spontanés (plus particulièrement *A. campestre*) du continent européen.

La remarquable pléophagie (orientée vers les genres *Aegilops*, *Agropyrum*, *Elymus*, *Haynaldia*, *Hordeum* et *Secale*) de la forme européenne de *P. agropyri* E. et E.* rejoint, par son ampleur et par sa structure, celle mise en évidence par les expérimentateurs du Nouveau-Monde en faveur du type américain de l'espèce. E. B. Mains - 1933 et G. W. Fischer - 1935 ont, en effet, reconnu, en Amérique septentrionale, le caractère polyphage des biotypes urédinéens accomplissant leur phase écidienne sur *Clematis*; les hôtes particulièrement réceptifs à cette sorte de Rouille se recrutent parmi les genres *Agropyrum* (*tenerum*), *Elymus* (*canadensis*, *condensatus* et *virginicus*), *Hordeum* (*jubatum*) et *Hystrix* (*hystrix*), tandis qu'une sensibilité moindre se manifeste chez les espèces *Agropyrum caninum* et *Hordeum gussoneanum* et *murinum* et que plusieurs espèces testées des genres *Bromus*, *Secale* et *Triticum* se sont révélées réfractaires.

Il nous paraît, enfin, intéressant de faire remarquer que le spectre phytoparasitaire de *P. agropyri* E. et E. se superpose à peu près à celui qui a été mis en évidence chez certaines races plurivores de *P. glumarum* Erikss. et Henn.; W. Straib - 1937 a, en effet, reconnu, à l'égard de la race 28 de *P. glumarum*, la nette réceptivité de plusieurs Graminées appartenant aux genres *Aegilops* (*ovata*), *Agropyrum* (*caninum* et *repens*), *Elymus* (*arenarius*, *canadensis* et *virginicus*), *Haynaldia* (*villosa*) et *Hordeum* (*maritimum*), tandis que *Bromus madritensis* se révélait peu sensible et qu'*Elymus europaeus* et *Hordeum murinum* et *secalinum* apparaissaient réfractaires.

* La grande diversité des hôtes de *P. agropyri* (forme européenne) suggère l'existence possible de races physiologiques inégalement spécialisées; le comportement variable de certains hôtes (par exemple *Agropyrum repens*, ainsi que le Seigle et le Blé) selon l'origine des souches testées le laisse également pressentir. Il ne sera possible de conclure définitivement en ce sens que par des observations méthodiques et prolongées; il apparaît que, de l'ensemble des résultats expérimentaux obtenus à ce jour, aucune indication nette de spécialisation parasitaire orientée ne semble se dégager.

ON THE *AGARICUS XANTHODERMUS* GROUP IN ISRAEL

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ABSTRACT

Species of the *Agaricus xanthodermus* group: *A. xanthodermus*, *A. meleagris*, *A. ammophilus* and a new variety *A. meleagris* var. *fibrillosus* found in Israel are described and their taxonomic state is discussed.

INTRODUCTION

The group of *Agaricus xanthodermus* (*Psalliota xanthoderma*) was established by Schaeffer and Moeller (1938). To the known characteristics of this group—the conspicuous yellow colour of the base of the stipe and the phenol or ink smell—these authors have added a new feature—the negative “Schaeffer reaction” or “Cross reaction”, i.e. one streak of aniline oil crossed with another streak of concentrated nitric acid on the surface of the pileus; the reaction is considered positive when red colour appears. These authors also mentioned for some species of this group a chrome yellow-orange reaction with anilin oil.

Moeller himself uses the distinctive character of the negative “Cross reaction” in his monographic study (1951), as do Kuehner and Romagnesi (1953). Konrad and Maublanc make use of this taxonomic feature only in their second volume of “Les Agaricales” (1952), while in the first volume (1949) this distinction is overlooked. Heim (1957) while accepting the taxonomic position of *Xanthodermus* as a special group does not mention the “Cross reaction” but quotes the anilin oil reaction. Pilat in his monographic study of the genus *Agaricus* (1952) does not take the “Cross reaction” into consideration. This may explain why he does not assign the *Xanthodermus* related species to a special group. Singer (1949) on the other hand, attaches great taxonomic importance to this reaction, and raises the *Xanthodermus* group to a section, naming it *Xanthodermatei*.

Controversial opinions exist with regard to the validity of some species included in this group. Schaeffer, who in 1925 named *P. meleagris* as a species, changed its taxonomic position in 1939 to a sub-species of *Psalliota xanthoderma*. Singer (1949) seems to consider these two species as synonymous. With regard to *A. ammophilus* Ménier, Maire considered it only as a variety of *A. xanthodermus*, whose opinion was later shared by Moeller (1951) and also Singer (1949).

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The fungi *A. xanthodermus*, *A. ammophilus* and *A. meleagris* have been found in Israel. The following study which deals both with their description and comparison might contribute to the clarification of some of the controversial taxonomic points mentioned above.

DESCRIPTIONS BASED ON THE SPECIMENS COLLECTED IN ISRAEL

Agaricus xanthodermus Genevier (Plate I A, B; Figures 1, 2)

Bull Soc. Fr. 23. 31. 1876

Under bushes, among decayed leaves, solitary or in small groups of 2-3 specimens. Rehovot, 2.11.1948; 12.11.1951; 13.12.1957.

Pileus: 5-7 cm, convex with a flattened center, when young somewhat slightly felty, then glabrous, silky, white, turning "Primuline Yellow" *) and "Yellow Ocher", when rubbed. In sun getting scaly and darker. *Reactions*: Anilin oil-yellow, "Cross reaction" negative. *Lamellae*: Free with slightly denticulate edges, pale grey when young. *Stipe*: 6-7 cm long and 10-15 mm broad, silky white, turning yellow chrome when rubbed, especially near the base; Cylindrical, sometimes bent, with a slightly marginate base, hollow. *Annulus*: Sheated above, pendulous, white, thin, generally covered underneath with white scales which become yellow when touched. *Flesh*: White, becoming yellow when cut or rubbed, especially near the base of the stipe; smell like phenol; *basidia* tetraspored. *Spores* in mass, dark purple-brown ("Mummy Brown"), $5.25-6\mu \times 3.25-4.5\mu$.

Agaricus ammophilus Ménier (Plate I C, D, E, F; Figures 3-6)

Bull. Sc. Nat. Ouest Fr. 3. 1893.

A. xanthodermus var. *ammophilus* Maire B. S. Myc. Fr. SLVIII 1908

Solitary, stipe very deeply immersed in sandy Soil in open area; Rehovot, 28.11.1951; 20.12.1951; 5.1.1952; and 1.12.1952; 15.1.1953; 20.11.1953; 24.11.1954; 15.12.1954; 21.12.1955.

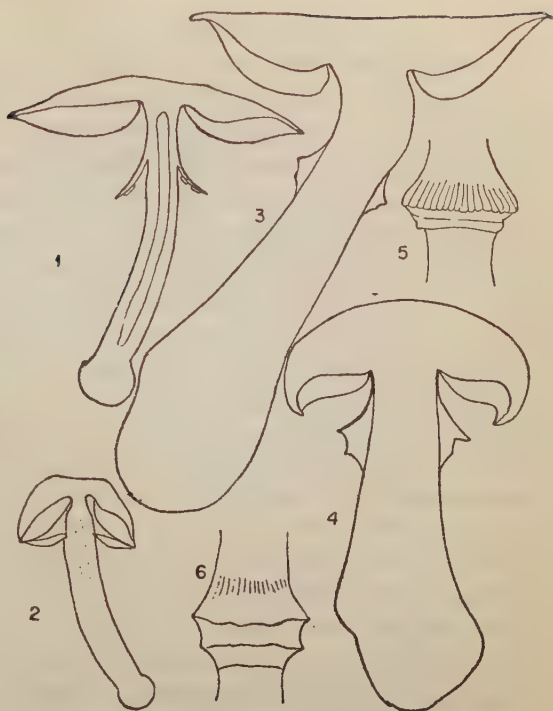
Pileus: 7-10 cm broad; at first subglobose, becoming hemispheric with a flattened disc, finally nearly plane; edge extending beyond the lamellae up to 6 mm, striate below; in young specimens cuticle slightly felty, then glabrous or nearly so; colour white, changing when rubbed into pale yellow ("Baryta Yellow"), when old becoming cream ("Catridge Buff"). *Reaction*: "Cross reaction" negative or slightly yellowish, with anilin oil-yellow-ochre. *Lamellae*: relatively narrow, 5-7 (15) mm, free, crowded, 85-100 near the stipe, in button stage whitish or pale cream ("avelaneous"), becoming "Light Congo pink", then rose-chocolate with a paler edge, finally entirely dark brown ("Army Brown"). *Stipe*: 8-9 cm long, 17-35 mm broad, silky-fibrous, solid, in button stage very thick and somewhat fusiform, later sub-cylindrical with a swollen subbulbous base, white, base turning yellow when rubbed. *Annulus*: high, thick near the stipe, with two edges separated by a circular furrow, the upper edge more prominent than the lower one (Figures 5-6).

* The colours in quotation marks are cited after Ridgway (1912).

Figures 1-2
Agaricus xanthodermus Genevier
($\times \frac{3}{4}$).

Figures 3-4
Agaricus ammophilus Menier
($\times \frac{3}{4}$).

Figures 5-6
Annuli of *Agaricus ammophilus*
Menier ($\times \frac{3}{4}$).



Flesh: In the pileus thick (up to 3 cm), white, with a slight vinaceous tinge—close to the lamellae, unchanging when cut, turning slightly yellow when scraped; in the stipe the flesh is silky-fibrous, white and changes when cut near the base immediately to yellow orange (“Empire Yellow” — “Deep Chrome”); odour slightly phenolic; eaten by us once without causing harm. **Spores:** $5.25-6.75 \times 4.5-5.25\mu$, broadly ellipsoid, “Natal Brown” in mass. **Basidia:** tetraspored, $19-23 \times 6-7.5\mu$.

Agaricus meleagris Schaeffer, (Plate II A, B, C)

Zeitschr. f. Pilzk. 4. 28. 1935.

Agaricus placomyces Peck. (?) Ann. Rep. N.Y. State Ms. 29.40.1878.

= *Psalliota xanthoderma* subsp. *meleagris* Schaeff. Führer f. Pilzfreunde 1. t. 47-58. 1939.

Gregarious, in small groups of 2-4 individuals; ruderal, near houses, generally in shade of plants; or of walls. Rehovot, 10.9.1950; 22.11.1950; 18.2.1951; 17.12.1951; 10.10.1952; 25.10.1952. 7.11.1952; 16.12.1952; 21.8.1953; 1.9.1953; 14.9.1953; 8.11.1953; 3.9.1954; 30.9.1954; 11.11.1955.

Pileus: 3-7 cm, convex with a flattened center, in button stage felty and brown; the cuticle cracks later on into adpressed small triangular fibrillous squamules, scarce towards the margin, showing a whitish-grey buff (“Tilleul Buff” or “Light Drab”) ground between, which turns, when rubbed, into slightly dirty yellow ochre and finally into dirty brown or vinaceous brown. **Reaction:** “Cross reaction” negative; anilin—bright yellow. **Lamellae:** Free, crowded, narrow, 0.5-1 cm, pale pink or pale grey then “Right Cinnamon Drab”, finally “Benzo Brown”. **Stipe:** 4-6 (10) cm

long, 8-11 mm broad, hollow, very narrow at the top when young, cylindrical, with a slightly marginate (up to 15 mm) bulbous base, silky, entirely white or pale pinkish above the annulus; when bruised or rubbed turns quickly into bright yellow ("Cadmium Yellow") especially near the base; this colour disappears with the time leaving a dirty viraceous brown. *Velum partiale*: White, thin, silky, adhering for a very long time to the pileus, often until its full expansion and the maturation of the spores. In high humidity drops of a brown liquid appear on the velum. *Annulus*: High, sheathed above, pendulous, large, striate, white above, often purplish-black because of the spores; doubled underneath by cottony scales situated in a circle which becomes yellow when touched. *Flesh*: White, turning yellow ("Deep Chrome". "Cadmium Yellow") mainly at the base of the stipe; the yellow colour is replaced later by a dirty pale brown-grey or brown-vinaceous color; strong smell of phenol. *Spores*: "Mummy brown" in mass, $5.25 \times 4.25-6\mu$; *basidia* tetraspored.

Agaricus meleagris Genevier var. **fibrillosus** var. nov. (Plate II, D. E.)

A. placomyces Peck(?) sensu A. H. Smith. Mushr. in their natural hab. Sawyer's Inc. 30 t. 1949.

A typo differt pileo convexo media parte raro plana; superficie parum humido, fibrillis fuscis sericeis tecto.

Caro pallide roseo-vinosa.

In herbidis humidis "St. Augustino" [*Stenotaphrum secundatum* (Walt.) Kunze] gregarius, per pluviam tempestatem, autumnno.

Differs from the type in the following characters:

Pileus convex, only seldom with a flattened centre, surface slightly moist, covered by brown, silky fibrils on a pale rose-vinaceous ground. Flesh: pale rose-vinaceous. Fruiting in very humid conditions.

In great groups on the lawns of "St. Augustine" grass [*Stenotaphrum secundatum* (Walt.) Kunze], Rehovot, 27.11.1954; 12.1.1955; 11.11.1955; 11.11.1956; 26.11.1956; 16.12.1956; 16.11.1957.

DISCUSSION

The four fungi described above have in common the three main features of the group *Xanthodermus*: 1. The negative "Cross reaction"; 2. the yellow colour of the base of the stipe; 3. the phenol-like smell.

A. meleagris Schaef. bears a great resemblance to *A. xanthodermus* Genev. However, according to Kuehner and Romagnesi (1953), Moeller (1951) and Pilat (1952), these are two different species with distinct features: *A. meleagris* has a brown or grey-brown pileus even in the button stage, covered with distinct fibrillose brown squamules in adult stage, while in *A. xanthodermus* the pileus is white and without squamules.

These differences seem to be very stable and without transitional forms: all our specimens of *A. xanthodermus* have white and naked pilei, while the young *meleagris*, collected by us many times, were always dark brown or dark grey-brown. Nor has Pilat (1952) found transitional forms between these two species. His indication that *meleagris* grows in more xerophytic conditions than *xanthodermus* seems to be true for our specimens too; *A. meleagris* appears in Israel in the late summer and autumn in dry conditions, while *A. xanthodermus* was found in early winter in sheltered places in a higher humidity.

A. meleagris var. *fibrillosus* var. nov. was found in two successive years growing in large groups in lawns of St. Augustine grass, in relatively highly humid conditions. This variety differs from the type species by: 1. the fibrilosity of the pileus; 2. the distinct pale rose-vinaceous colour of ground of the pileus appearing between the fibrils; and 3. pale rose-vinaceous colour of the stipe and flesh. No transitional forms were found between this variety and the type.

The *A. meleagris* var. *fibrillosus* shows resemblance to the specimens of *A. placomyces* as described and photographed by Smith (1949). This author writes: "Stipe . . . sometimes staining yellow", while in our fungus the yellow colour which appears on the base of the stipe is very conspicuous and constant.

A. ammophilus Ménier is considered by Maire (1910), Moller (1951) and Singer (1949) as a variety of *A. xanthodermus* Genev. For several years we have collected samples of this fungus and we think that it is not only very different from *A. xanthodermus* by its general habit but that there are at least 9 features which distinguish them. These features are listed in Table I.

TABLE I
Distinctive features between A. xanthodermus and A. ammophilus

	<i>Agaricus xanthodermus</i> Fig. 1-2	<i>Agaricus ammophilus</i> Fig. 3-6
Pileus	(1) White, becoming darker in the sun (2) In the sun often breaking or splitting into scales	White in all conditions Not splitting, glabrous or nearly so
Stipe	(3) Relatively thin 10-15 mm (4) Hollow (5) Not deeply immersed in the soil	Thick 17-35 mm Solid Very deeply immersed in the soil
Annulus	(6) Thin, pendulous, covered underneath with scales	Thick, with two edges separated by a furrow
Flesh	(7) Phenolic odour distinct	Phenolic odour very slight
Habitat	(8) On remnants of leaves (9) Under bushes in the garden	Deeply immersed in sandy soil (under dry edaphic conditions) In open area

Taking all these facts into consideration we agree with the conclusion of Konrad and Maublanc (1952): "La variété *ammophilus* (Ménier) Maire des sables maritimes du littoral atlantique, par son port, son anneau double, mérite sans doute d'être regardée comme espèce distincte". We therefore do not think that Maire was right by lowering Ménier's species to a variety of *A. xanthodermus*: these two fungi are entirely different and *A. ammophilus* is a valid species.

ACKNOWLEDGMENTS

The author is indebted to Prof. I. Reichert for having read the manuscript and given his suggestions: also to Mrs. T. Itinzon and Dr. R. Kenneth for help in collecting the material.

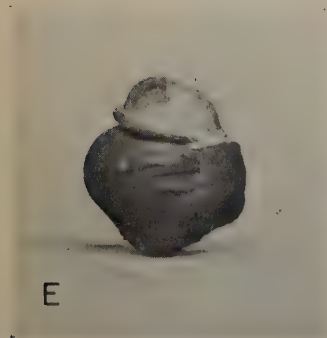
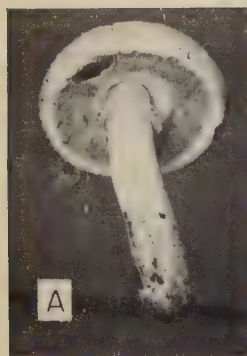


Plate I

A, B. *Agaricus xanthodermus* Geneviev ($\times 2/3$)
 C-F. *Agaricus ammophilus* Ménier (C: $\times 2/3$, D: $\times 1/2$, E: $2/3$, F: $\times 1/2$).



Plate II

A-C. *Agaricus meleagris* Schaeffer (A: 2/3, B: $\times 1\frac{1}{2}$, C: nat. size).

D-E. *Agaricus meleagris* Gener. var. *fibrillosus* Aviz.-Hershenz. (D: $\times 1/2$, E: $\times 2/3$)

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THE RUSTS ON *SCORZONERA* AND *TRAGOPOGON*

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ABSTRACT

On the members of the *Scorzonera* section *Euscorzonera* occur two rust species, viz. the brachy-form *Puccinia hieracii* (Röhl.) Mart. and the auteu- to opsis-form *P. jackyana* Gäum., while the auteu-form *P. podospermi* DC. is limited to the section *Podospermum*. On *Tragopogon* lives the opsis-form *P. hystrium* (Str.) Röhl. The often used name "*P. scorzonerae*" is rejected as invalid. Apparently *P. jackyana* possesses the largest number of host species. However, various species of *Scorzonera* carry rusts which it has not been found possible to identify with certainty as to species. Also other rusts than those mentioned above and living on *Scorzonera* and *Tragopogon* are treated.

INTRODUCTION

The various autoecious, macrocyclic *Puccinia* forms on *Scorzonera* (incl. *Podospermum*) and *Tragopogon* must be considered closely allied, and earlier they were often placed together under the names *P. tragopogi* (Pers.) Wint. or *P. tragopogonis* Corda. However, both auteu-forms, opsis-forms and brachy-forms are represented, and without inoculation experiments or continued observation of the development of the rust on infected plants it may prove difficult or even impossible to identify the rust in question, for the following reasons:

1. The aecidial stage, which always (together with spermogonia, which may be lacking, however) develops from a systemic mycelium, may occur on other host specimens than the diploid phase.

2. In brachy-forms spermogonia (from a localized mycelium) are visible a short time only, and are mostly not present at collecting time.

3. On some host species apparently transitions occur between the auteu-type and the opsis-type, as sometimes uredosori are more or less prominent, while sometimes uredospores are solely found intermixed in the teleutosori, or uredospores may not be present at all.

In all these rusts the teleutospores have at least the lower germ-pore more or less depressed, and in the rusts on *Scorzonera* the uredospores possess mostly 2 super-equatorial germ-pores, although in *Puccinia jackyana* and *podospermi* not seldom even approximately equatorial.

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It seems possible to segregate the following 4 species:

- Teleutospores conspicuously verrucose. Systemic aecidial stage present.
 Teleutospore wall 2.5–4.5 μ thick. Chiefly auteu-form.
 Teleutospore wall 2–3 μ thick. Opsis-form.
 Teleutospores minutely punctate-verrucose, wall mostly 2–2.5 μ thick.
 Systemic aecidial stage present. Auteu-form to opsis-form.
 Aecidia absent, spermogonia from a localized mycelium. Brachy-form.

P. podospermi
P. hystereum

P. jackyana
P. hieracii

The material on *Scorzonera* and *Tragopogon* examined partly belongs to the Botanical Museum of the University in Oslo (O), and partly to the Swedish Museum of Natural History in Stockholm (S). The writer is much indebted to the Botanical Division of the last-mentioned Museum for the loan.

The much used name *P. scorzonerae* must be rejected as invalid. Both *P. scorzonerae* (Schum.) Juel, 1896, and *P. scorzonerae* (Schum.) Jacky, 1899, are based upon *Uredo scorzonerae* Schum., 1803, on *Scorzonera humilis*. As pointed out by Tranzschel (1939 p. 391), Schumacher's description suggests *Albugo tragopogi* S. F. Gray (syn. *Cystopus cubicus* de Bary); in fact, Lind (1913 pp. 57 and 330) lists it as synonymous with *Cystopus cubicus* as well as with *P. scorzonerae* (Schum.) Jacky. *P. scorzonerae* ("Schum.") Juel corresponds to *P. hieracii* (Röhl.) Mart. occurring on *Scorzonera humilis* and although the description is rather imperfect, the name may perhaps be considered properly published. On the other hand, *P. scorzonerae* ("Schum.") Jacky must be rejected not only as a later homonym, but also as a nomen confusum. The teleuto-stage and possibly also the uredo-stage was described from a specimen on *S. purpurea* distributed in Sydow, Ured. 485 and probably corresponding to *P. hieracii*, while the aecidial stage must have been described from *Scorzonera austriaca* and corresponds to *P. jackyana*.

***Puccinia hieracii* (Röhl.) Mart., Prodr. Fl. Mosq., ed. 2: 227. 1817.**

P. flosculosorum var. *hieracii* Röhl., Deutschl. Fl., ed. 2, III, 3: 131. 1813. — *O* + *II* + *III*.

The following synonyms concern *P. hieracii* on *Scorzonera humilis*:

- Puccinia plantaginis* West., Bull. Acad. R. Belg., 30, 2. ser. 11: 649. 1861. Type from Luetie-St. Pierre, Belgium, on "*Plantago lanceolata*" = *S. humilis* (cp. Tranzschel 1904 pp. 159–160)
P. scorzonerae ("Schum.") Juel, Öfvers. K. Vetensk.-Akad. Förh. 53: 222. 1896. Type from Gotland, Sweden.
P. scorzonericola Tranz., Ann. Mycol., 2: 161. 1904. Lectotype from Lavashevo near St. Petersburg, Russia.

Teleutospores attenuated or rounded basally, finely punctate-verrucose with 2–2.5 μ thick wall; they do not exceed a breadth of 27 μ . Uredospores with 2, mostly super-equatorial germ-pores.

Already Schroeter (1889 p. 334) recognized the rust on *S. humilis* as a brachy-form and consequently placed it with *P. hieracii*. The absence of aecidia was later confirmed by Juel (1896 p. 222) and Tranzschel (1904 pp. 160–161). The present rust is of regular *P. hieracii* type and must be placed in this compound species. If considered a separate species it would be necessary, acc. to the Nomenclature Rules, to use the misleading, but validly published oldest name, viz. *P. plantaginis* West., notwithstan-

ding that the host was originally wrongly determined (cf. the American rust *P. pyrolae* Cooke on *Polygala*).

On *Scorzonera humilis* L. The rust has been found from France and N. Italy through Germany, Austria, Czechoslovakia, Poland, the Baltic Provinces and White Russia northward to Belgium, Denmark, S. Sweden, S. Finland and the Leningrad district of Russia. However, the host has a wider southern and southeastern European distribution.

On *S. rosea* W. et K. It seems that aecidia have never been collected on this host and although spermogonia are not reported, it is to be surmised that the rust in question belongs to *P. hieracii*. *II + III* are reported from Yugoslavia, Roumania and Polish Galicia.

On *S. purpurea*. L. P. and H. Sydow (1924 p.54) consider the rust on this host a brachy-form, which is probably correct, as the host is closely allied to *S. rosea*, but as far as known spermogonia have not been reported. *II + III* from the vicinity of Krakow in Poland (leg. M. Raciborski) are distributed in Sydow, Ured. 485, and these stages are also reported from the Polish Carpathians by Namyslowski (1911 p. 99) and Wroblewski (1915 p.124). However, Severini (1907 p. 297) reports *O + I* on this host from Perugia in N. Italy, but it depends on whether the host was correctly determined.

On *S. radiata* Fisch. For this host Tranzschel (1939 p.374) reports *P. scorzonericola* Tranz. (= *P. hieracii*), referring to 3 finds of *II + III* in Siberia. From Sakhalin Ito (1950 p.335) reports "*P. scorzonerae* (Schum.) Jacky" on the same host, without specifying the spore-forms found.

As hosts for *P. scorzonerae* (Schum.) Juel (= *P. hieracii*) are mentioned by Gäumann (1953 p.272 and 1959 p.1118), besides *S. humilis*, *S. rosea* and *S. purpurea*, also "*S. mollis* M. B. = *S. undulata* Vahl" and *S. papposa*. However, the rusts on *S. undulata* and *S. papposa* apparently belong to *P. jackyana*, while the specific status of that on *S. mollis* at present seems uncertain.

An aecidial stage of "*P. scorzonerae*" is recently reported for *S. humilis* from French mountains, viz, Hautes-Alpes (Guyot and Massenot 1958 p.494) and French Jura (Viennot-Bourgin and Bondoux 1959 p. 66). Professor A. L. Guyot has kindly informed me (in litt.) that in the former instance the host was really *S. hispanica*, and it is to be suspected that also in the other instance the host was wrongly determined.

Puccinia jackyana Gäum. Sydowia, 7: 272; Die Rostpilze Mitteleuropas: 1115, 1959. Latin diagnosis is lacking — *O + I + (II) + III*.

P. scorzonerae auct. p.p., non Juel, Öfvers. K. Vetensk.-Akad. Förh. 53: 222. 1896 [= *P. hieracii* (Röhl.) Mart.]; nec Jacky, Zeitschr. f. Pfl. krankh. 9: 285. 1899 (nomen confusum).

Type on *Scorzonera austriaca*, Oswaldpromenade near Bozen, Italian Tyrol.

Latin diagnosis for *Puccinia jackyana*, somewhat abbreviated after Gäumann's German description.

Spermogoniis melleis, in foliis et caulibus distributis. Aecidiis per totam superficiem foliorum sparsis, etiam in caulibus et involucris, cupulatis, margine albedo, laciniato. Aecidiosporis globosis, polyedricis ad ellipsoideis, intus aurantiacis, $27\ \mu$ (raro ad 35μ) longis et 18μ latis; episporio hyalino, dense verruculoso, poris germinationis 3. Uredosoris rotundatis vel elongatis, brunneis. Uredosporis globulatis ad ellipsoideis, pallide brunneis, $20-32 \times 20-26\mu$; episporio echinulato, poris germinationis 2, super-aequatorialibus. Teleutosporis conformibus, atro-brunneis. Teleutosporis ellipsoideis vel clavatis, medio non constrictis, apice rotundatis, basi plerumque attenuatis, $27-36 \times 17-20\mu$; episporio verruculoso, poro germinationis cellulae superioris fere $1/3-1/2$ depresso, cellulae inferioris fere $1/3$ depresso, uterque sine papilla; pedicello hyalino.

Gäumann found that the rust on *S. austriaca* is an auteu-form and separated it from *P. podospermi* on behalf of the teleutospores being narrower, mostly attenuated basally and less strongly verrucose; however, the systemic aecidial stage and the uredospores are similar in the two species. As other hosts Gäumann (1959 p. 1116) mentions *S. hispanica* L. and *S. rosea* W. and K., but the latter is known to carry *P. hieracii*. As a matter of fact, many species of the section *Euscorzonera* carry rusts of essentially similar type as that on *S. austriaca*, although the uredo-stage is often reduced and may be lacking. Besides, the teleutospores may vary considerably with respect to form, e.g. on many hosts being mostly rounded basally. However, the teleutospores are always minutely punctate-verrucose and their wall comparatively thin, mostly $2-2.5\mu$ thick; they seldom exceed a breadth of 30μ . The uredospores possess 2 mostly super-equatorial, but not rarely even approximately equatorial germ-pores.

Jacky (1899 p.285) looked upon "*P. scorzonerae* (Schum.) Jacky" as an auteu-form, but Hariot (1908 p.149) as an ophis-form. The rust on *S. austriaca* P. et H. Sydow (l.c.) considered a *Pucciniopsis*, and under the name "*P. scorzonerae* Jacky p.p." Tranzschel (1939 p.391) mentions it as being of ophis-type, but adds that in *Scorzonera* rusts of this type some uredospores may occur among the teleutospores. However, according to Gutzevitch (1952 p.143) rather many uredospores may occur in this way (as hosts he mentions *S. hispanica* and *S. austriaca*). On the other hand, Gäumann (l.c.) and Savulescu (1953 p.1023) describe uredosori on *S. austriaca* and *S. hispanica*, respectively. In *P. jacksyana* there clearly exists a transition between the auteu-type and the ophis-type as mentioned under point 3 on p. 179.

On *Scorzonera austriaca* Willd. The rust is reported, chiefly in the aecidial stage, from N. Italy and Moravia, while Tranzschel (l.c.) reports it with *I* and *III* from the Crimea, Kazakhstan and E. Siberia, and Liou and Wang (1934 p.160) with *O* + *I* + *II* + *III* from Peiping in China (here separate uredosori are described).

On *S. eriosperma* M. B. A specimen from the Botanic Garden in Tiflis, Georgia, (leg. G. Woronow, June 17, 1912; S) contains *I* + *III*, but no uredo; this collection

has previously been mentioned by P. and H. Sydow (1924 p.54). *O* + *I* were collected at the same place by G. Newodowski on May 5, 1911 (S).

On *S. hispanica* L. Known to occur in Spain, France, the Netherlands, N. Italy, S. Germany, Austria, Czechoslovakia, Hungary, Yugoslavia, Roumania and the Crimea. It shows the same variation from auteu-form to opsis-form as on *S. austriaca*.

On *S. lanata* (L.) M. B. Is reported from Russian Azerbajdzhan by Voronichin (1927 p.145) and Tranzschel (l.c.), with *I* + (*III*) and *I*, respectively.

On *S. papposa* DC. *I* + *II* + *III* are reported by Rayss (1951 p.183) from Palestine and may without much doubt be placed with *P. jackyana*.

On *S. pusilla* Pall. Tranzschel (l.c.) reports *I* + *III* on this host from the Stalingrad district in S. Russia.

On *S. stricta* Hornem. Tranzschel (l.c.) reports *I* + *III* and Nevodovsky (1956 p.90) *I* from Kazakhstan.

On *S. undulata* Vahl. On this N. African host material of *II* + *III* from El Hafay in Tunis has been examined (leg. S. Murbeck, April 24, 1896); (O). The uredospores possess 2, more or less equatorial or irregularly located germ-pores. Aecidia are reported from Algeria by Maire (1927 p.124) and from Morocco by Guyot and Malencon (1957 p.135).

On *S. villosa* Scop. [= *Gelasia villosa* (Scop.) Cass.]. Material of *II* from Trieste (leg. O. Dahl, May 1902; O) has been examined; germ-pores 2, super-equatorial or equatorial. *I* is reported (as *Aecidium galasiae* Syd.) from Görz (Goritzia) near Trieste (distributed in Sydow, Ured. 1699) and from Istria by H. and P. Sydow (1903 p.252), further from Fiume by Moesz (1918 p.[34]).

Scorzonera RUSTS WITH DOUBTFUL SPECIFIC STATUS

The rusts on the following species of *Scorzonera* are, if not otherwise stated, reported as *P. scorzonerae* (Schum.) Jacky or *P. scorzonerae* Jacky. Most of them probably belong to *P. jackyana*.

On *S. albicaulis* Bge. Reported from Korea by Hiratsuka (1942 p.58) and Ito (1950 p.335). The latter author gives a Japanese description of *O*, *I*, *II* and *III* and a drawing of uredo- and teleutospores, but also *S. radiata* from Sakhalin is given as a host, and the kind of spore-forms found on each separate host is not indicated (from Siberia *S. radiata* is reported to carry *P. hieracii*).

On *S. calyculata* Boiss. A specimen collected in N. Persia (Gilan) at 3000 m by J. and A. Bornmüller (June 26, 1902; S) has been examined; teleutospores $30-42 \times 15-26\mu$, long and narrow ones dominating. Only *III* was seen, but P. and H. Sydow (1924 p.54) found in the same collection "Teleutosporenlager mit ziemlich reichlich beigemischten Uredosporen".

On *S. hirsuta* L. Gonzalez Fragoso (1924 pp. 345-346) reports only this host for *P. scorzonerae* (Schum.) Jacky in Spain, and gives a drawing of teleutospores. All spore-forms are described, but the description largely follows that of P. and H. Sydow (1904 p. 142) for the rust species mentioned and gives no information of those found on *S. hirsuta*. From France Brunaud (1889 p.87) reports *P. tragopogonis* (Pers.) Corda on the present host.

On *S. mollis* M. B. [= *Podospermum molle* (M.B.) F. et Mey.]. Treboux (1912 p.317) and Tranzschel (l.c.) report *P. podospermi* DC. on this host (which is usually considered belonging to *Euscorzonera*) from Novotcherkask in S. Russia, but material collected by O. Treboux at that place on April 18, 1911 (S) consists solely of aecidia. Aecidia have also been collected by J. and A. Bornmüller in N. Persia (Gilan) at 2200 m (May 12, 1902; S), viz. on *S. mollis* var. *flaviflora* Bornm. I have seen no records of *II* and *III* on this host.

On *S. parviflora* Jacq. Tranzschel (l.c.) reports *III* from Ukraina (teleutospores $35-43.5 \times 29-35\mu$) and *I* + *III* from Kazakhstan; from the latter republic Nevodovsky (1956 p.98) has a drawing of teleutospores, the size of which he gives as $36-43 \times 31-35\mu$. The large teleutospores remind of *P. meshedensis* Petr. from Persia.

On *S. pygmaea* Sibth. et Sm. Reported from the Atlas Mountains in Morocco by Maire and Werner (1937 p.73), but spore-forms are not mentioned.

On *S. aff. sericea* Auch. Systemic *O* + *I* are reported from Asia Minor by Henderson (1959 p.78) as *P. scorzonerae* Juel.

Puccinia podospermi DC., in Lamk. et DC. Fl. fr., ed. 3, 2: 595. 1805. — *O* + *I* + *II* + *III*.

Type on "podosperme decoupé" = *Scorzonera laciniata*, France.

The teleutospores are mostly rounded at both ends, conspicuously verrucose and with 2.5–4.5 μ thick wall; not seldom they exceed a breadth of 30 μ . Uredosori are as a rule present; the uredospores possess 2, super-equatorial or approximately equatorial germ-pores.

This rust is common on *Scorzonera laciniata* L. [= *Podospermum laciniatum* (L.) DC.] in South and Middle Europe and eastward to Caucasia and Russian Central Asia, also in Morocco, Algeria and Tunisia. Within the same area it has been found also on *S. calcitrapifolia* Vahl [= *Podospermum calcitrapifolium* (Vahl) DC.] and on *S. jacquiniana* (Koch) Boiss. [= *Podospermum jacquinianum* Koch and *P. canum* C. A. M.]; both have often been considered varieties of *S. laciniata*.

P. podospermi is with certainty known only for the above-mentioned members of the *Scorzonera* section *Podospermum*.

The uredo-stage appears often to be rather scanty and short-living, and sometimes to be totally lacking. Thus, in a specimen on *S. laciniata* from the Spanish Pyrenean province Huesca (leg. N. Y. Sandwith, July 7, 1956; *O*), taken at ca. 1250 m. aecidia and teleutosori occur on the same leaves, but no uredo.

Puccinia hystereum (Str.) Röhl., Deutschl. Fl., ed.2, III, 3: 131.1813. — *O* + *I* + *III*.

Uredo hystereum Str., Ann. Wetter. Ges. 2: 110. 1810. (*III*).

Puccinia tragopogonis Corda, Icon. Fung., 5: 50. 1842.

P. tragopogi Wint, Hedwigia, 19:44, 1880 (based upon *Aecidium tragopogi* Pers., Syn. meth. Fung.: 211. 1801).

Type on *Tragopogon pratensis*, Germany.

The teleutospores are mostly rounded at both ends, conspicuously verrucose, with the wall about 2–3 μ thick; they are extremely variable in size and exceed sometimes 30 μ in breadth. One-celled ones are fairly common. According to de Bary and various later authors, a few uredospores are sometimes ("manchmal" according to P. and H. Sydow 1904 p.169) found intermixed in the teleutosori, but satisfactory description is lacking; thus, germ-pores have never been mentioned. The present writer has examined numerous specimens without finding uredospores.

This rust is common in Europe on *Tragopogon pratensis* L. incl. ssp. *orientalis* (L.) Velen. (= *T. orientalis* L.) and ssp. *minor* (Mill.) Hartm. (= *T. minor* Mill.). Other European hosts are *T. brevirostris* DC. (= *T. floccosus* W. et K.), *T. dubius* Scop. (= *T. major* Jacq.), *T. glaber* (L.) Benth. et Hook. (= *T. hybridus* L.) and *T. porrifolius* L., on the last-mentioned host also in Siberia. Found, further, in Caucasia on *T. graminifolius* DC., in the Near East on *T. buphtalmoides* Boiss. and

T. palaestinus Boiss. (= *T. buphtalmoides* var. *palaestinus* (Boiss.) Dinsm.), and in Russian Central Asia on *T. ruber* Gmel., besides, as also in W. Pakistan on unidentified species of *Tragopogon*.

According to Schroeter (1879 p.79) *II* + *III* of *P. hieracii* type have been found at Memel on *T. floccosus*. It is perhaps to be expected that the host was wrongly determined.

OTHER RUSTS ON *SCORZONERA* AND *TRAGOPOGON*

Puccinia meshedensis Petrak in Ann. naturh. Mus. Wien 50 (1939): 422. 1940.

On *Scorzonera* sp., Prov. Khorasan in Persia. Only *III* has been described, but very probably the rust is no micro-form. The teleutospores are large ($30-45 \times 22.5-41\mu$) and thick-walled (c. $3-5\mu$), smooth or minutely verrucose. The position of the lower germ-pore is not mentioned. This rust probably belongs to the same group as the other rust species on *Scorzonera* and *Tragopogon* treated above, but is hardly conspecific with any of them; however, it may perhaps be the same as the rust on *S. parviflora* mentioned above (p.183).

Puccinia brachycyclica Ed. Fisch. in Ber. schweiz. bot. Ges. 43: 176. 1934.

P. tragopogi (Pers.) Corda ssp. *brachycyclica* (Ed. Fisch.) Tranz., Consp. Ured. URSS: 391. 1939.

On *Tragopogon pratensis* L. s. lat. Spermatophytes and teleutospores develop from a systemic mycelium in deformed leaves. This micro-form must be considered derived from *P. hysteriorum*, as the teleutospores in both species are similar. The rust is reported from Switzerland, France and Germany. According to Gäumann (1959 p.1128) *T. orientalis* L. is the type host and he also lists as hosts *T. dubius* Scop., *T. porifolius* L. and *T. pratensis* L.

The two following ones concern aecidia belonging to heteroecious rusts.

Puccinia tranzscheliana Brezhnev in Bot. Zhurnal SSSR 31: 42, 1946 (nomen nudum); Notulae syst. Sect. crypt. Inst. bot. Komarovii, 6: 80 1949.

Aecidia in clusters from localized mycelia on *Tragopogon brevirostris* DC. in the Kursk district of Russia were experimentally proved to belong to a rust of *P. dioicae* type on *Carex colchica* Gay. Tranzschel (1939 pp. 373-374) reports similar aecidia from Russia on *T. pratensis* L. (incl. *T. orientalis* L.) and *T. brevirostris* DC. (incl. *T. floccosus* auct.).

Aecidium scorzonerae Lagh. in Tromsø Mus. Aarsh. 17 (1894): 105. 1895.

On *Scorzonera angustifolia* (no author given) at Misamas in France. Aecidia in clusters from localized mycelia and probably belonging to a *Carex* rust. Hariot (1908 pp. 296-297) describes similar aecidia on *S. parviflora* Jacq. at Bouches-du-Rhône in France. P. and H. Sydow (1924 p.54) were wrong in placing *A. scorzonerae* with *Puccinia angustifoliae* Mc. Alp., on alleged *S. angustifolia* in Australia; acc. to Osborn and Samuel (1922 pp. 169-170) the host of this rust species is *Podotheca angustifolia* Less., which belongs to Inuleae-Gnaphaliinae. The type host of *A. scorzonerae* perhaps coincides with *S. angustifolia* DC. = *S. humilis* var. *angustifolia* Willd.

The rust species *Puccinia crepidis* Schroet., on *Crepis*, and *P. rhagadioli* Thuem., on *Rhagadiolus* possess systemic aecidial stage and resemble considerably the auctoform on *Scorzonera*. However, the uredospores in *P. crepidis* possess 2–3 germ-pores, and those in *P. rhagadioli* mostly 3. All the host genera in question are members of Liguliflorae, but while *Scorzonera* and *Tragopogon* belong to the subtribe Scorzonerinae, *Crepis* belongs to Crepidinae and *Rhagadiolus* to Rhagadiolinae.

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LE GENRE *SPHAERODOTHIS* SHEAR

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ABSTRACT

In the present revision of the genus *Sphaerodothis* eight species are recognized, two of which, *S. phoenicis* and *S. steinheilii* (= *S. chamaeropsis* Shear) are new combinations. *Coccostroma palmicola* (Speg.) v. Arx et Müll. is the synonym of *S. acrocomiae* as probably also is *S. guilielmae*.

RESUME

Dans cette révision du genre *Sphaerodothis*, 8 espèces sont reconnues, dont le *S. phoenicis* n. comb. et le *S. steinheilii* n. comb. (= *S. chamaeropsis* Shear). *Coccostroma palmicola* (Speg.) v. Arx et Müll. est un *Sphaerodothis* et est synonyme de *S. acrocomiae*. *S. guilielmae* est probablement aussi synonyme de *S. acrocomiae*.

Le genre *Sphaerodotis* Shear (1909), rangé dans les Sphaeriales Polystigmataceae comprend des espèces foliicoles sous-épidermiques ou envahissant toute l'épaisseurs de la feuille. Le pseudostroma, noir et souvent friable, renferme un ou plusieurs périthèces. Les asques, à membrane mince, et les paraphyses sont fugaces. Les ascospores, libérées hyalines, deviennent brunes en mûrissant. Les différentes espèces peuvent se répartir de la façon suivante:

- + Asques cylindriques, ascospores en ordre monostique
 - stroma envahissant toute la feuille; ascospores globuleuses: 1. *Sph. arengae*
 - stroma localisé sur une seule face; spores ellipsoïdes: 2. *Sph. densa*
- + Asques globuleux, spores sans ordre, non enrobées de mucus
 - stroma contenant un seul périthèce: 3. *Sph. phoenicis*
 - stroma contenant le plus souvent deux périthèces: 4. *Sph. merianae*
 - stroma contenant un grand nombre de périthèces: 5. *Sph. steinheilii*
- + Asques largement claviformes, spores enrobées de mucus
 - ascospores montrant un sillon longitudinal: 6. *Sph. neowashingtoniae*
 - ascospores lisses: 7. *Sph. acrocomiae* et 8. *Sph. guilielmae*

1. *Sphaerodothis arengae* (Rac.) Shear

Syn.: *Auerswaldia arengae* Rac. (Paras. Alg. u. Pilze Javas 3: 27, 1900) — *A. copelandi* Syd. (Ann. myc., 4: 343, 1906). — *Sphaerodothis arengae* Shear (Mycologia 1: 162, 1909).

Chez cette espèce, bien décrite par v. Arx et Müller (1954), le pseudostroma envahit toute l'épaisseur de la feuille. Les asques cylindriques ($150-210/16-25\mu$), octosporés, contiennent des ascospores subglobuleuses ($15-21/13-18\mu$), alignées, brun clair.

Matériau observé: *A. arengae* sur *A. saccharifera*, Buitenzorg 1899, Rehm 1468.

Elle se développe sur les feuilles de l'*Arenga saccharifera* Labill., *A. obtusifolia* Mart. et *Caryota propinqua* Blume, en Indonésie et aux Philippines.

2. *Sphaerodothis densa* (Bomm. et Rouss.) Shear

Syn.: *Auerswaldia densa* Bomm. et Rouss. (Bull. Soc. roy. bot. Belg. 35: 162, 1896). —

Sphaerodothis densa Shear (Mycologia 1: 163, 1909). — *Phaeochora densa* Theiss. et Syd. (Ann. myc. 13: 403, 1915) — ? *Phyllachora gaylussaciae* P. Henn. (Hedw. 41: 303, 1902).

Le stroma, large et aplati, est localisé sur une seule face de la feuille. Les asques cylindriques ($110-12\mu$) renferment des spores en ordre monostique, elliptiques ($14-17/7.5\mu$), brun-olivacées à maturité.

A été décrite sur des feuilles coriaces indéterminées, à Costa-Rica.

3. *Sphaerodothis phoenicis* (Rolland) Joly comb. nov. (Figure 1a, b, c.)

Syn.: *Ceratostoma phoenicis* Roll. (Bull. Soc. myc. Fr. 7: 96, 1891). — *Anthostomella* (?) *molleriana* Trav. et Sp. (Bol. da Soc. Brot. 25: 146, 1910).

Les pseudostromas noirs, aplatis, isolés ou confluent, allongés longitudinalement et recouverts par l'épiderme, apparaissent macroscopiquement gris-vertâtre. Chaque stroma renferme un seul périthèce, haut de 89μ ($75-100$) et large de 512μ ($440-580$), à ostiole ovale ou allongée. Les asques octosporés, globuleux ou oblongs, ont une membrane mince, hyaline, fugace. Les jeunes asques, 24.7μ ($20-35$) \times 11.0μ ($9-13$), contiennent des spores hyalines à deux globules peu colorables au bleu coton. On trouve quelques asques de 37.0μ ($31-52$) \times 16.5μ ($13-19$) renfermant des spores qui ont presque atteint la taille adulte, mais encore hyalines. Les ascospores mûres, ellipsoïdes, 12.6μ ($8-14$) \times 6.8μ ($5-8$), légèrement asymétriques, jaune sale ou fauve, ont un contenu homogène. Elles restent parfois groupées par huit après la gélification des parois de l'asque.

Matériau observé: échantillon récolté par T. Rayss à Rehovot (Israël), oct. 1957; — *C. phoenicis*, Golfe Juan, nov. 1890, Rolland; — *C. phoenicis*, Cannes, ex herb. Boudier.

Cette espèce n'a été signalée que sur le *Phoenix dactylifera* L., dont elle parasite le rachis des feuilles mourantes ou sèches. Outre les mentions de sa présence, faites avec les descriptions par Rolland dans le sud de la France, et par Traverso et Spessa au Portugal, elle n'a été signalée que par Fawcett (1931), qui mentionne l'existence d'une striation brune des vieux pétioles de *P. dactylifera*, liée à l'*Anthostomella* (?) *molleriana*, en Egypte, Algérie, Tunisie, Palestine, Arizona et Californie. Le fait que ce parasite, à l'aire de répartition aussi vaste, soit si peu mentionné dans la littérature

phytopathologique semble indiquer qu'il ne constitue pas un danger important pour les plantations. Toutefois, le Prof. T. Rayss, qui nous en a communiqué un échantillon, nous l'a indiqué comme ayant causé des dégâts en Israël.

4. *Sphaerodothis merianae* Orejuela (Mycologia 36: 445. 1944)

Le stroma, convexe et circulaire, renferme le plus souvent deux loges très larges. Les asques octosporés, largement cylindriques, contiennent des spores sans ordre déterminé, elliptiques, 25–31/16–19 μ .

Sur *Meriana nobilis*, Colombie.

5. *Sphaerodothis steinheilii* (Montagne) Joly comb. nov. (Figure 1: d, e, f)

Syn.: *Sphaeria steinheilii* Montagne (Ann. Sc. nat., 2 ser. Bot. 1: 285. 1834). — *Anthostomella* ? *steinheilii* Sacc. (Syll. Fung. 1: 293. 1882). — *Dothidea chamaeropsidis* Cke (Grev. 7: 96. 1878). — *Auerswaldia chamaeropsis* Sacc. (Syll. Fung. 2: 626. 1883). — *Sphaerodothis chamaeropsis* Shear (Mycologia 1: 162. 1909). — *Phaeochora chamaeropsis* v. Hohn. (Sitz.-Ber. k. Akad. Wiss. Wien 118: n. 444. 1909). — *Sphaeropsis dothideoides* Sacc. et Roum. (Michelia 2: 348. 1881). — *Haplosporella dothideoides* Sacc. (Syll. Fung. 3: 324. 1884). — *Sordaria palmicola* Auersw. (Un. Itin. crypt., Nr. 58. 1866). — *Anthostomella palmicola* Rabenh. (Fung. europ. Nr. 2522. 1880).

Les pseudostromas, bombés, noir-carbonacés, allongés longitudinalement, sous-épidermiques, sont de taille variable selon le nombre de périthèces qu'ils contiennent. Les périthèces, à base carrée et sommet arrondi, mesurent 134 μ (80–190) de haut sur 136 μ (70–210) de large, et sont tapissés intérieurement d'une mince assise hyaline. A l'état mûr, ils ne contiennent que des ascospores. Les asques octosporés, globuleux, à paroi mince et hyaline, sont fugaces; leur taille maximum observée est de 47 \times 25 μ . Les ascospores largement elliptiques, légèrement asymétriques, 23.2 μ (19–27) \times 15.6 μ (13–17), d'abord hyalines, deviennent brun-rougeâtre à maturité. L'épispore, épaisse, est nettement rouge, la mésospore mince et brune. Le contenu des spores est granuleux, avec souvent deux grandes plages rondes à contenu plus homogène.

Matériel observé: *S. steinheilii*, Ain Kebira (Mascara), avril 1844, ex herb. Durieu; — *S. steinheilii*, Maison-Carrée, 1870, Cordier ex herb. Dr. Roussel; — sub *Phoma chamaeropium* Desm. nom. nudum, Sydi Féruch, juin 1830, Desmazières (det. Montagne); — *S. palmicola*, Sardaigne, 1866, Marcucci, ex. herb. Durieu et herb. Roumeguère. — *H. dothideoides*, mars 1891.

Cette espèce, fréquente en Afrique du nord, parasite les feuilles et les pétioles du *Chamaerops humilis* L. et a été trouvée sur *Sabal blackburnianum* Glaz. aux Bermudes (Vizioli 1923).

6. *Sphaerodothis neowashingtoniae* Shear (Mycologia 1: 162, 1909)

Syn.: *Phaeochora neowashingtoniae* Theiss. et Syd. (Ann. myc. 13: 402. 1915).

Le pseudostroma contient de nombreux périthèces. Les asques octosporés, globuleux (100–120 μ) renferment des spores hyalines, enveloppées de mucus. Les ascospores mûres sont brunes, elliptiques (56–68 \times 30–36 μ) et possèdent un sillon longitudinal.

Sur les feuilles du *Neowashingtonia filamentosa*, Californie.

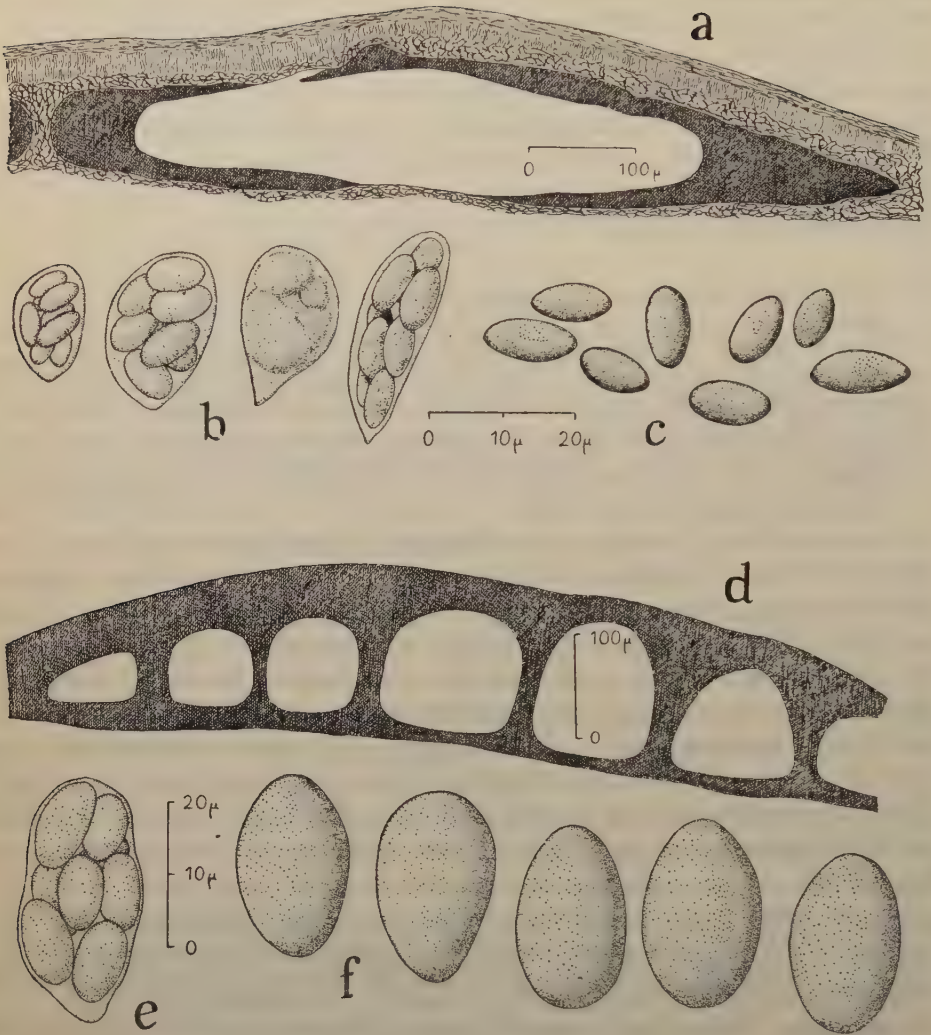


Figure 1

a-c: *Sphaerodothis phoenicis* (Rolland) Joly comb. nov.

a. stroma uniloculaire; b. asques à divers stades, dont un avec avortement des ascospores; dans ce cas, très rare, l'asque persiste, devient brun et est libéré avec les ascospores; nous ne savons pas s'il est capable de germer; c. ascospores mûres

d-f: *Sphaerodothis steinheilii* (Montagne) Joly comb. nov.

d. stroma pluriloculaire; e. asque contenant les jeunes ascospores; f. ascospores mûres

7. *Sphaerodothis acrocomiae* (Montagne) v. Arx et Müller.

Syn.: *Dothidea acrocomiae* Montagne (Syll. crypt.: 223. 1856). — *Phyllachora acrocomiae* Sacc. (Syll. Fung. 2: 606. 1883). — *Phaeochora acrocomiae* Theiss. et Syd. (Ann. myc. 13: 402. 1915). — *Sphaerodothis acrocomiae* v. Arx et Müll. (Beitr. z. Kryptogamenfl. d. Schweiz 11:(1): 246. 1954). — *Auerswaldia rimosa* Speg. (Fung. Guar. 2: 41. n. 115). — *Sphaerodothis rimosa* Shear (Mycologia 1: 162. 1909). — *Hysterodothis rimosa* v. Höhn. (Sitz.-Ber. k. Akad. Wiss. Wien 118t: N. 444. 1909). — *Auerswaldia palmicola* Speg. (An. Soc. Cien. Argent. 19: 247. 1885). — *Sphaerodothis palmicola* Shear (Mycologia 1: 162. 1909). — *Dothidina palmicola* Theiss. et Syd. (Ann. myc. 13: 304. 1915). — *Bagnisiopsis palmicola* Petr. (Hedw. 68: 285. 1928). — *Leveillinopsis palmicola* Stev. (Illin. biol. Mon. 8: 179. 1923). — *Coccostroma palmicola* v. Arx et Müll. (Beitr. z. Kryptogamenfl. d. Schweiz 11 (1): 264. 1954). — *Montagnella astrocaryae* Rehm (Hedw. 36: 379. 1897). — *Camarotella astrocaryae* Theiss. et Syd. (Ann. myc. 13: 370. 1915). — *Bagnisiopsis astrocaryae* Petr. (Ann. myc. 38: 243. 1940). — *Phyllachora astrocaryi* P. Henn. (Hedw. 43: 87. 1904). — *Bagnisiopsis astrocaryi* Petr. et Syd. (Ann. myc. 27: 97. 1929). — *Hypoxydon desmoncyi* Rehm (Hedw. 40: 142. 1901). — *Plowrightia diplothemii* Rehm (Hedw. 36: 378. 1897). — *Bagnisiopsis diplothemii* Theiss. et Syd. (Ann. myc. 13: 294. 1915). — *Auerswaldia felipponeana* Sacc. (Ann. myc. 13: 130. 1915). — *Coccostromopsis palmigena* Plunk. (Illin. biol. Mon. 8: 176. 1923). — *Bagnisiopsis stevensii* Petr. (Ann. myc. 27: 232. 1929).

Le pseudostroma, sous-épidermique et allongé, devient très volumineux et fend longitudinalement l'épiderme. Sur certains échantillons (*S. rimosa* typique), le stroma, encore restreint, apparaît entre les deux lèvres de l'épiderme fendu. Lorsque le stroma est bien développé, il écarte et retourne ces lèvres, qui forment alors une collerette autour du stroma puis se desquament, mais on en retrouve souvent des fragments à la base des stromas les plus développés, globuleux et entièrement nus (*C. palmicola* typique). Le stroma, noir mat, à surface crevassée, forme alors de grosses verrues sur les feuilles. Il contient généralement de 3 à 10–12 périthèces de formes irrégulières (Figure 2; a), hauts de 220μ (200–280) et de largeur très variable, souvent inférieure à la hauteur. L'intérieur est tapissé d'une couche assez épaisse d'éléments hyalins. Les asques sont fugaces. Chez le très jeune asque, allongé ($55\text{--}60 \times 8\text{--}10\mu$), le contenu de l'asque apparaît replié en accordéon ou enroulé en hélice; puis les spores s'individualisent (Figure 2; b), l'asque s'élargit beaucoup, $80\text{--}100/20\text{--}30\mu$, devient largement claviforme (Figure 2; c), puis la paroi, toujours mince et hyaline, disparaît avant la maturité complète des spores. Les jeunes ascospores, hyalines, renferment 2 à 4 globules non colorables au bleu coton; ces spores sont incluses dans une masse de mucilage dont les contours suivent le tracé sinueux du contenu du jeune asque. Puis cette masse de mucilage se découpe autour de chaque spore et la membrane de l'asque disparaît, libérant les spores encore hyalines, chacune enrobée dans une gangue de mucus. Les ascospores mûres, 21.5μ (18–26) $\times 8.8\mu$ (7–11), sont ovoïdes, presque symétriques, de teinte fauve clair, à épispore fine noirâtre et à contenu homogène.

Matériau examiné: *Phyllachora acrocomiae* Montagne, typus! — *Auerswaldia rimosa* sur *Cocos yatai* (Balansa, Pl. Parag., 4068) et sur *Acrocomia* (Balansa, Nr. 3965); — *A. palmicola* sur *Diplothemium littorale* (Balansa, Nr. 4325) et sur *Cocos yatai* (Balansa, Nr. 3559).

Cette espèce, décrite sur *Acrocomia sclerocarpa*, *A. yatai*, *Cocos*, *Diplothemium littorale* en Amérique du Sud, a été également signalée sur *Ascrista monticola* à

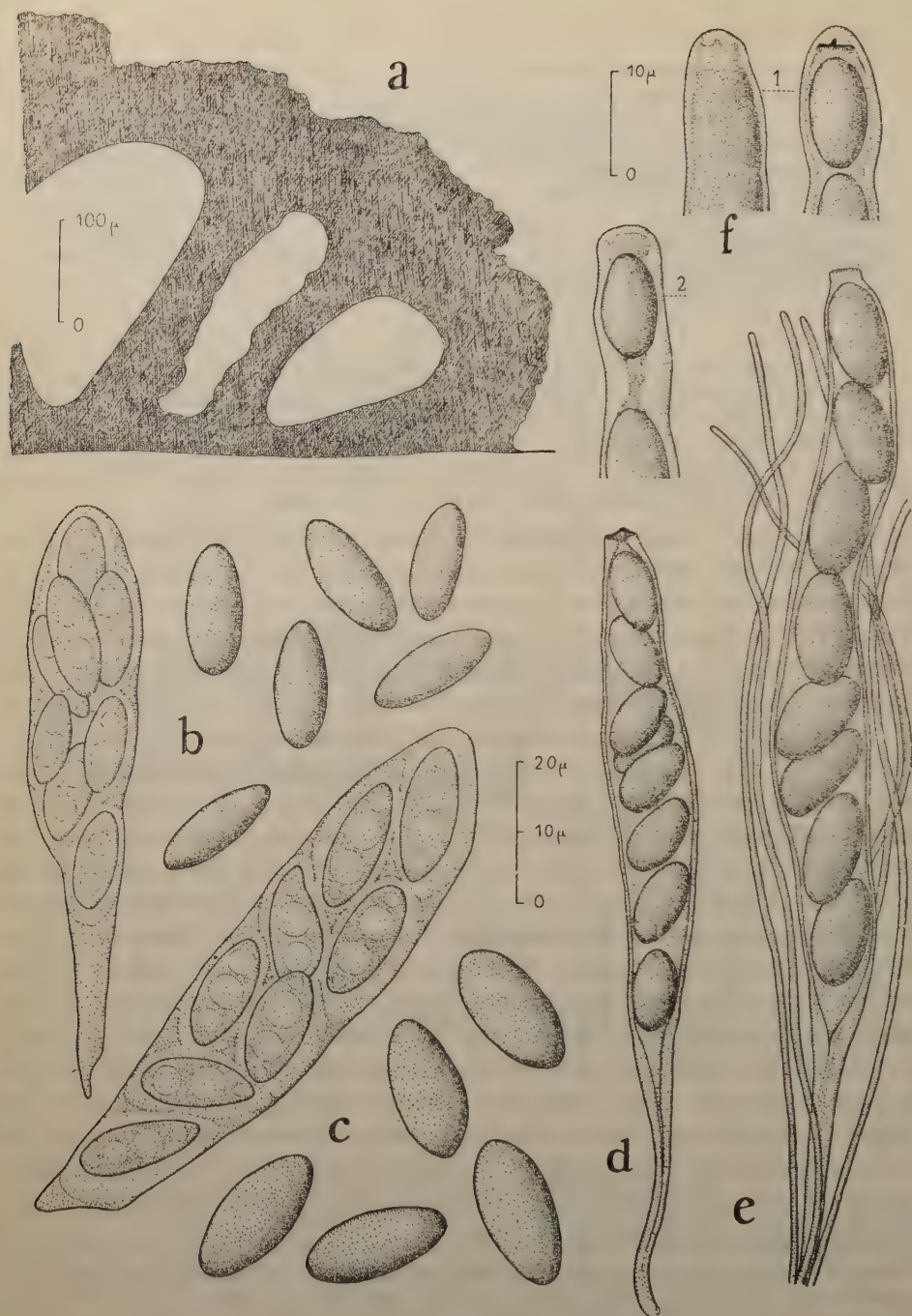


Figure 2.

a-c: *Sphaerodothis acrocomiae* (Montagne) v. Arx et Müller.

a. stroma globuleux pluriloculaire (Balansa Nr. 3559); b. asques et ascospores (Balansa Nr. 3559); c. asques et ascospores (Balansa Nr. 4068) (Asques colorés au bleu coton C. 4B.). d-f. genre *Coccostroma* Theiss. et Syd. d. asque mûr de *C. melastomatum* (Lév.) v. Arx et Müll.; e. asque mûr et paraphyses de *C. peribebuyensis* (Speg.) v. Arx et Müll.; f. appareil apical des asques de *Coccostroma*: 1. *C. melastomatum*, 2. *C. peribebuyensis*

Porto-Rico (Garman 1915). Malgré le comportement éruptif du pseudostroma, l'évolution des asques et des ascospores font du *S. acrocomiae* une espèce très voisine du *S. neowashingtoniae*. Elle se distingue très nettement du genre *Coccostroma* Theiss. et Syd., chez qui les paraphyses sont persistantes, les asques également persistants, à paroi plus épaisse (Figure 2; d, e) et munis d'un appareil apical très net (Figure 2; f) libérant les ascospores entièrement mûres.

8. *Sphaerodothis guilielmae* (P. Henn.) Shear

Syn.: *Auerswaldia guilielmae* P. Henn. (Hedw. Beibl. 39: 78. 1900). — *Sphaerodothis guilielmae* Shear (Mycologia 1: 163. 1909). — *Phaeochora guilielmae* Theiss. et Syd. (Ann. myc. 13: 402. 1915).

Cette espèce dont le stroma fait saillie par une fente longitudinale de l'épiderme, et dont les asques, largement claviformes, 100–130/18–30 μ , contiennent des ascospores hyalines à 2 globules devenant brunes, de 17–19/9–12 μ , est très voisine du *S. acrocomiae* et probablement synonyme. Toutefois, n'ayant pu l'étudier, nous la laissons provisoirement distincte.

Sur feuilles de *Guilielma speciosa*.

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DE QUELQUES PARASITES DE PLANTES ORNEMENTALES

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ABSTRACT

Five parasitical fungi of ornamental plants are described in this note. One species, *Colletotrichum rayssi*, on *Asarum europaeum*, is new for science and is dedicated to Professor T. Rayss. The other fungi are *Coryneum microstictoides* on *Paeonia moutan*, *Phyllosticta violae* on *Viola tricolor*, *Pringsheimia karelii* on *Jasminum fruticans* and *Septoria leucanthemi* on *Leucanthemum vulgare*.

1. *Colletotrichum rayssiae* sp. nov.

Les feuilles d'*Asarum europaeum*, cultivé dans un jardin à Verrières-le-Buisson (Seine et Oise), présentaient, au mois de septembre 1955, de grandes macules décolorées, devenant jaunâtres sur la fin et portant par places des plages nécrotiques plus foncées, le plus souvent zonées.

Sur certaines de ces plages nécrotiques, le parasite fructifiait en donnant des acervules de 100 à 150 μ de diamètre, hérissées de longs poils brun-foncé, raides, atteignant 250 μ de long; les spores, portées par des conidiophores courts tapissant la surface externe d'un petit stroma lenticulaire, unicellulaires, hyalines, cylindrico-fusoides, droites ou un peu arquées, subobtusées aux extrémités, pluriguttulées, mesurent $18-29 \times 2.5-4\mu$ en moyenne $25.7 \times 3.2\mu$.

Le champignon ainsi décrit correspond au genre *Colletotrichum* dont aucune espèce n'a été, à notre connaissance, signalée à ce jour sur *Asarum europaeum*.

En respectueux hommage à Mademoiselle T. Rayss, nous proposons le nom de *Colletotrichum rayssiae* pour ce champignon nouveau qui peut accepter la diagnose latine suivante:

Colletotrichum rayssiae sp. nov.

Maculis brunneo-nigris, zonatis, definitis, in areis majusculis primo decoloratis, deinde flavidis; acervulis sparsis, punctiformibus, nigris, 100-150 μ diam.; setis rectis, acutis, obscure brunneis, usque 250 μ longis, conidiophoribus mixtis; sporis cylindrico-fusoideis, hyalinis, rectis vel subcurvulis, pluriguttulatis, $18-29 \times 2.5-4\mu$, in medio $25.7 \times 3.2\mu$.

Hab. in foliis vivis *Asari europaei* cult., in horto Galliae septentrionalis.

2. *Coryneum microstictoides* Cast.

Cette espèce était assez commune, au printemps de 1954, sur les Pivoines arbustives (*Paeonia moutan* et ses variétés), au Jardin Botanique de l'Ecole Nationale d'Agriculture de Grignon.

Les acervules apparaissent en groupes sur les rameaux, généralement autour d'une cicatrice foliaire; le bourgeon axillaire correspondant se dessèche et ne se développe pas. Il ne semble pas que ce dessèchement des bourgeons soit dû, exclusivement du moins, à la présence du champignon; il s'agit soit d'un dégât de gel, le *Coryneum* se développant ultérieurement en simple saprophyte, soit plutôt d'une action combinée du gel et du champignon qui se comporterait alors en parasite de faiblesse.

Les spores, brun-olivâtres, ovoides ou oblongues, régulièrement triseptées, mesurent $12-17 \times 5.5-7 \mu$.

3. *Phyllosticta violae* Desm. (= *Phyllosticta violae* f. *violae-tricoloris* Sacc. = *Phoma violae-tricoloris* Diedicke)

Le parasite a été observé, au mois de mai 1953, sur les feuilles de Pensée cultivée (*Viola tricolor maxima*), dans les chassis, près de la grande serre de l'Ecole Nationale d'Agriculture de Grignon (Seine et Oise).

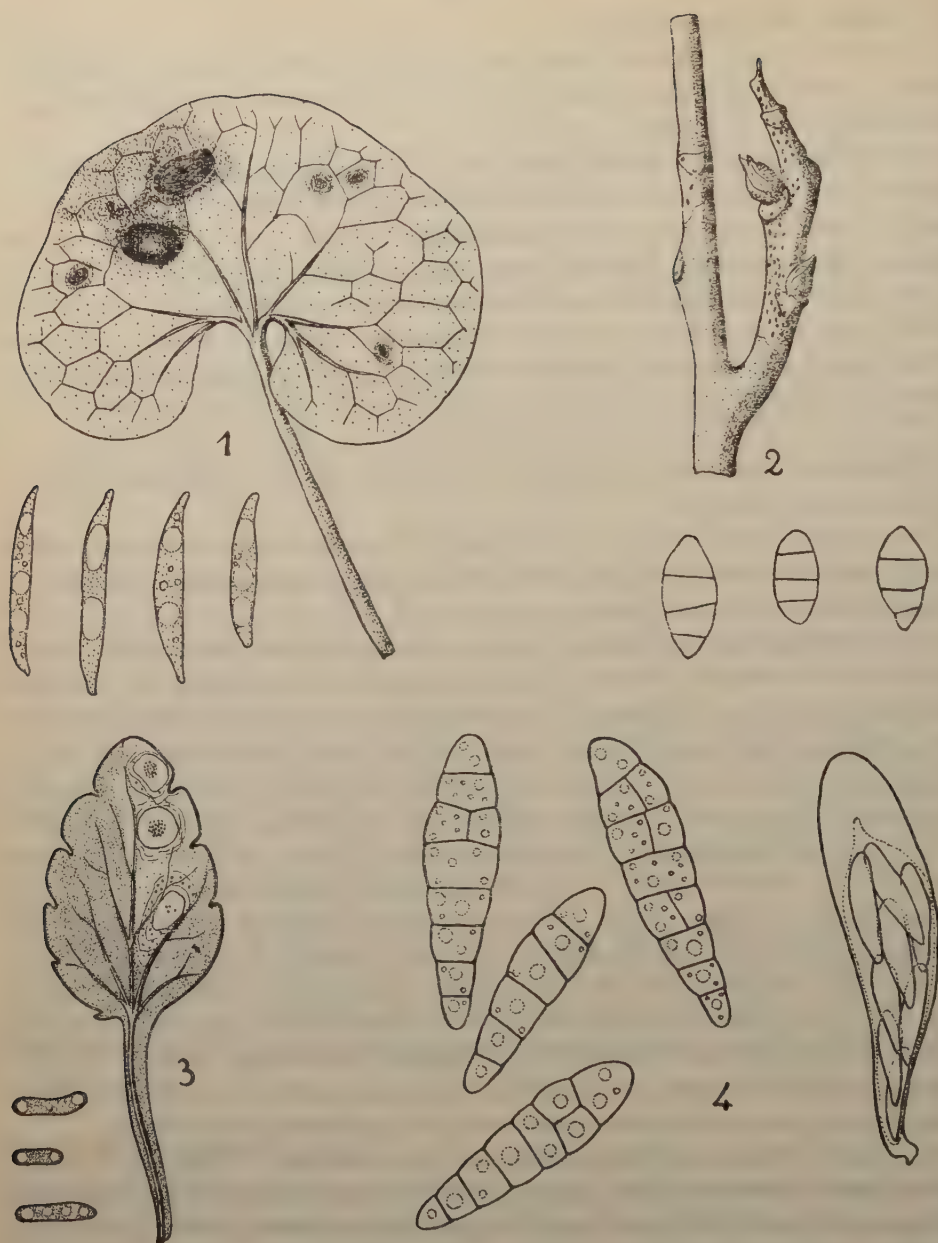
Sur les feuilles des plantes qui n'avaient pas été repiquées, on pouvait observer de nombreuses macules foliaires, de contour irrégulier, présentant des zonations concentriques, pouvant atteindre 1.5 cm de long et 1 cm de large et qui, à première vue, auraient pu être confondues avec des dégâts de *Ramularia*. Si elles n'avaient pas été parsemées de nombreuses petites pycnides de 100 à 160 μ de diamètre, disposées en groupe au centre de la macule ou dispersées sur toute la surface de la tache.

Les pycnides contiennent de nombreuses spores hyalines, continues, cylindriques, arrondies aux deux extrémités, bi- ou pluriguttulées, mesurant $6.5-12.5 \times 1.5-2.5 \mu$.

La diagnose originale de *Ph. violae*, parasite de *Viola odorata*, assez imprécise, fait état de spores pouvant atteindre 10 μ de long; Saccardo (1879) décrit ultérieurement la forme *violae-tricoloris* sur *Viola tricolor*, dont les spores biguttulées mesurent $6 \times 2.5 \mu$; enfin, Diedicke (1904) décrit, sur les feuilles et les tiges de *Viola tricolor* cult., *Phoma violae-tricoloris* dont les spores, biguttulées également, mesurent $10 \times 2.5 \mu$. Ces trois espèces ou formes ne semblent pas nettement distinctes les unes des autres et nous pensons pouvoir les réunir sous le nom de *Phyllosticta violae* Desm.

Par contre, *Phyllosticta libertiae* Sacc. sur *Viola odorata*, à pycnides et spores petites (pycnides: 80-90 μ diam.; spores $1-1.5 \times 0.7-1 \mu$), *Phyllosticta libertiana* Sacc. et March. sur *Viola odorata* et *biflora*, à pycnides très petites (60-70 μ diam.) et à spores assez petites ($3-4 \times 2-2.5 \mu$), enfin *Phoma violicola* Syd. sur *Viola altaica*, à pycnides et spores grandes (pycnides: 150-210 μ diam.; spores $10-14 \times 2-3 \mu$, uniguttulées) semblent nettement distincts de *Ph. violae*.

Les dégâts observés à Grignon étaient assez importants pour provoquer le flétrissement de nombreuses plantes mais étaient probablement très accentués du fait de la contiguïté anormale de plantes issues de semis et non encore repiquées.



1. *Colletotrichum rayssiae* n. sp. : feuille parasitée (grandeur nature) et spores ($\times 1000$).
2. *Coryneum microstictoides* Cast. : rameau parasité (grandeur nature) et spores ($\times 1000$).
3. *Phyllosticta violae* Desm. : feuille parasitée (grandeur nature) et spores ($\times 1000$).
4. *Pringsheimia karelii* Petrak : asque ($\times 800$) et spores ($\times 1200$).

4. *Pringsheimia karelii* Petrak.

Sur les rameaux desséchés de *Jasminum fruticans* L., au Plan de la Sainte Baume, près Marseille (Bouches du Rhône), vers 600 mètres d'altitude, nous avons observé, au mois de mai 1949, de très nombreux petits périthèces de 150 à 250 μ de diamètre, à paroi épaisse de 20 à 40 μ , formés sous la pellicule la plus externe de l'écorce qui prend une coloration gris argentée. Ces périthèces renfermaient des asques clavi-formes, disposés parallèlement les uns aux autres, fortement épaissis au sommet, courtement pédicellés, entremêlés de paraphysoides et mesurant $50-105 \times 15-22 \mu$; les ascospores hyalines, oblongo-fusoides, arrondies aux deux extrémités, à 6-7 cloisons transversales, pourvues, chez certaines, d'une cloison longitudinale intéressant 1 ou 2 loges, plus rarement trois loges, finement et densément guttulées, mesuraient $25-32 \times 7-9 \mu$.

Ainsi décrit, la parasite doit être rapporté au genre *Pringsheimia*. Nous avons hésité, à l'époque, à rapporter le parasite à *Pr. sepincola* (Fr.) v.H., espèce très polyphage pour laquelle Wehmeyer (1957) propose de revenir à l'appellation de *Sacothecium sepincola* (Fr.) Fr. mais dont les asques et ascospores sont plus petits que ceux de notre champignon sur Jasmin; nous avons provisoirement abandonné l'étude de cet échantillon lorsque Monsieur P. Bernaux, de Montpellier, nous a adressé le même parasite, en association d'ailleurs avec *Leptosphaeria castagnei* Sacc., récolté sur les rameaux de *Jasminum fruticans*, près de Montpellier (Hérault), le 12 janvier 1958. Pour cette dernière récolte, les périthèces, à paroi épaisse de 20 à 50 μ , mesurent 150-300 μ de diamètre; les asques admettent pour dimensions $45-80 \times 18-22 \mu$, les ascospores, $22-32 \times 6-9 \mu$, asques et ascospores présentant par ailleurs les mêmes caractères que pour la récolte de la Sainte Baume.

Nous avons alors soumis ces deux récoltes à la compétence de Monsieur le Professeur E. Müller de Zürich, que nous remercions bien vivement pour son extrême obligeance, qui a bien voulu nous signaler que F. Petrak (1956) venait de décrire *Pringsheimia karelii* Petr. sur des rameaux de *Jasminum fruticans* récoltés en Turquie (Kûtahya, Simav, 8 juillet 1953), dont la diagnose s'accorde bien aux caractères des deux récoltes du Midi de la France. Le Professeur E. Müller nous écrit en outre, dans une lettre datée du 30 juillet 1959: "Pendant notre excursion au massif de la Sainte Baume, j'ai aussi trouvé ce champignon que j'ai isolé en culture; les caractères culturels de *P. sepincola* et de *P. karelii* sont différents et je crois qu'il s'agit réellement d'une forme particulière."

5. *Septoria leucanthemi* Sacc. et Speg.

Nous avons trouvé le parasite sur les feuillets d'une variété ornementale de *Leucanthemum vulgare* qui croissait dans un jardin à Verrières-le-Buisson (Seine et Oise), en octobre 1955.

La maladie est bien caractérisée par de larges macules foliaires zonées concentriquement, de couleur brun-roux, qui portent les pycnides du parasite. Ces dernières,

globuleuses, membranacées, à large pore pouvant atteindre $65\ \mu$ de diamètre, mesurent $90\text{--}250 \times 85\text{--}185\ \mu$. Les spores, filiformes, uni- ou pluricellulaires admettent pour dimensions $40\text{--}100 \times 2\text{--}3.5\ \mu$.

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A PROPOS D'UN *MICROSPHAERA* SUR *SPARTIUM JUNCEUM* L.

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ABSTRACT

Etude morphologique d'un *Microsphaera* développé sur les tiges et les feuilles de *Spartium junceum* L. dans le sud-ouest de la France et en Suisse. Il résulte de cette étude qu'il s'agit d'une espèce morphologiquement différente de celles observées jusqu'ici sur les Papilionacées, *Microsphaera rayssiae* sp. nov.

Les derniers jours de juillet 1959, nous avons observé dans les environs d'Albi, département du Tarn (France), sur une des collines au sud-ouest de la ville, une Erysiphacée intéressante sur *Spartium junceum* L. Notre attention a été attirée sur un pied qui se trouvait être considérablement déformé du fait d'une fasciation; le buisson en entier présentait des rameaux plus ou moins élargis et aplatis, surtout à leur extrémité. Sous l'effet de ces anomalies, l'extrémité des rameaux était aussi très anormale, ce qui avait entraîné la stérilisation de tout le buisson, les bourgeons terminaux ayant tous avortés.

Examinant de près cet étrange *Spartium junceum*, nous avons constaté à notre grande surprise que toutes les extrémités des rameaux plus ou moins déformés, tordus et aplatis, étaient attaquées par un *Oidium* leur formant comme un sorte de revêtement d'un blanc grisâtre. A maints endroits, nous pouvons relever la présence de très nombreux périthèces, en parties enfouis dans l'épais feutrage du mycelium, cela aussi bien sur les deux faces des feuilles que sur les tiges.

En étudiant de près ce parasite, nous avons constaté que cette Erysiphacée ne se rattachait pas à *Erysiphe martii* Lév., comme nous le pensions au moment de la récolte, mais appartenait à une espèce du genre *Microsphaera*. La question se posait dès lors de savoir si notre parasite pouvait se rapporter à l'une ou à l'autre des espèces déjà signalées sur les Papilionacées. Pour pouvoir répondre à cette question, nous avons commencé par procéder à un examen aussi détaillé que possible de notre *Microsphaera*.

Nous avons observé que l'*Oidium* est attaqué d'une manière très massive par *Cicinnobolus cesatii* de Bary, sans parler d'autres parasites appartenant à des champignons imparfaites. De ce fait, l'*Oidium* est assez altéré, car il est exceptionnel de

trouver des endroits où le *Cicinnobolus* n'exerce pas sa funeste influence. C'est certainement la raison pour laquelle l'*Oidium* se présente sous l'aspect d'un blanc grisâtre sale, au lieu d'être franchement blanc.

Les conidies hyalines, elliptiques ou plus ou moins en forme de tonneau, sont en chaînettes sur des conidiophores hyalins; elles mesurent, pour un comptage de 100 spores, $23-40 \times 12-19 \mu$, le plus souvent $26-33 \times 14-16 \mu$, longueur moyenne 30μ , largeur moyenne 14μ .

Les périthèces à maturité sont noirs ou d'un brun très foncé, sphériques, parfois quelque peu aplatis dans leur partie reposant sur le mycelium; ils mesurent $87-150 \mu$ de diamètre, pour un comptage de 100 périthèces, la très grande majorité ayant $106-117 \mu$, avec deux maxima évidents à 106μ et à 117μ ; beaucoup ont un diamètre au-dessous de 87μ , mais il s'agit alors de périthèces en voie d'évolution et n'étant pas encore à maturité. Les cellules constituant les périthèces forment une masse compacte et il est difficile de les individualiser; cependant après écrasement des périthèces, on arrive à les distinguer moins mal; elles mesurent de 10 à 18μ . Les appendices des périthèces sont le plus souvent au nombre de $10-20$, rarement moins, plus rarement davantage; ils sont hyalins, souvent subhyalins un peu brunâtres à leur base; ils ne sont pas septés, assez fragiles et se brisant facilement du fait qu'ils sont pris dans l'épais feutrage mycélien; ils sont plus ou moins régulièrement répartis sur toute la circonférence des périthèces, mesurent jusqu'à 950μ de longueur, peut-être même davantage, car il n'est pas facile de voir des périthèces dont les appendices ne sont pas brisés à leur extrémité; ils sont assez raides, souvent coudés, surtout dans leur partie inférieure; ils ont une largeur de $7-9 \mu$ à leur base et de $6-8 \mu$ dans leur partie moyenne.

L'extrémité des appendices se termine en dichotomies, mais on ne constate pas leur présence sur tous les appendices. Comme c'est le cas, surtout chez *Microsphaera astragali*, elles sont relativement assez rares; il n'est pas fréquent de les observer et on peut examiner plusieurs périthèces sans voir un seul appendice se terminer en dichotomies, probablement aussi du fait qu'ils se brisent facilement à leur niveau. Le plus souvent on constate, dans les préparations, les dichotomies à l'extrémité d'appendices brisés et n'étant plus en relation directe avec les périthèces. De ce fait, la longueur totale des appendices est difficile à déterminer exactement et doit dépasser les indications ci-dessus; il a été possible de mesurer une longueur totale, y compris les dichotomies, de 900μ , mais des appendices ne se terminant pas en dichotomies peuvent atteindre jusqu'à 950μ de longueur. Il n'a pas été possible de déterminer si tous les appendices se terminent normalement en dichotomies, ou seulement quelques-uns, ou encore un certain nombre sur un périthèce; il semble certain que chez notre *Microsphaera*, comme c'est le cas chez *M. astragali*, quelques appendices seulement se terminent en dichotomies, alors que les autres n'en présentent pas et encore ces dichotomies ne se manifestent-elles pas pour tout les périthèces.

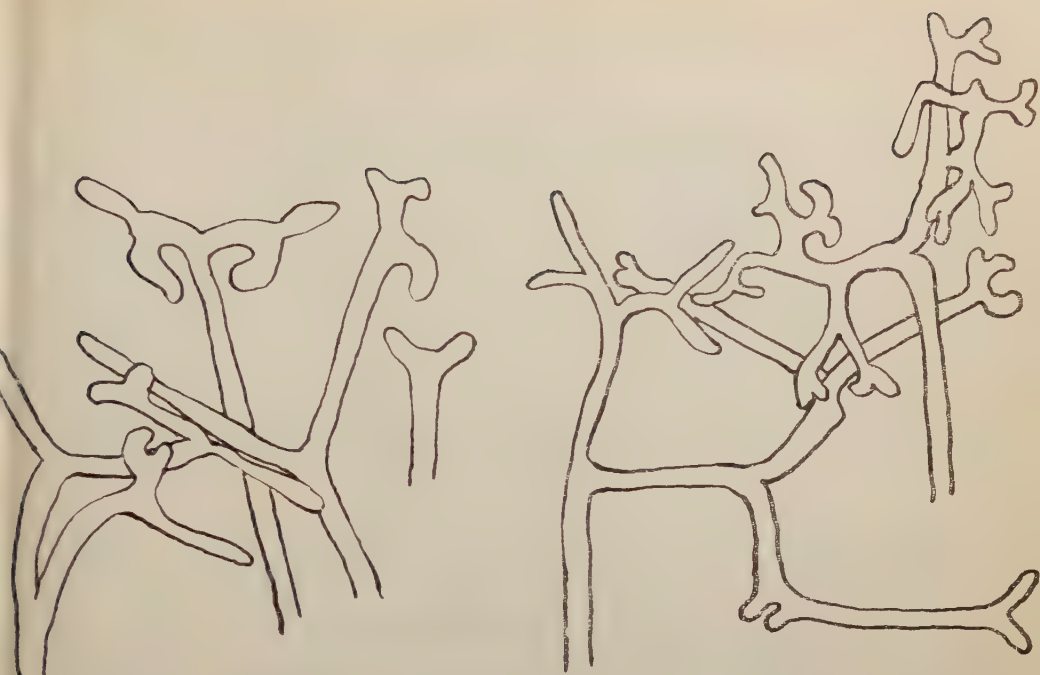


Figure 1

Microsphaera rayssiae sp. nov.Dichotomies des appendices (Albi, France). $\times 500$.

Les dichotomies à l'extrémité des appendices sont très variables en nombre et en grandeur, ainsi que par leur apparence. Ou bien on ne constate qu'une sorte de fourche terminale à angle très ouvert, dont les extrémités sont arrondies et pas en pointe, ou bien le plus souvent on observe des dichotomies au nombre de 2 à 5, très irrégulières et sans aucun ordre, souvent non divisées à leur extrémité, ou se terminant par des protubérances arrondies et sans forme bien déterminée, ou encore l'extrémité des dichotomies se termine par des fourches arrondies et non pointues, ni surtout recourbées. L'épaisseur de l'appendice, au niveau de la première division, est de 6–7 μ , celle des dernières ramifications est de 4–5 μ .

Les périthèces renferment de 2 à 7 asques, du moins nous n'en avons pas constaté davantage; il pourrait cependant y en avoir un plus grand nombre, car la plupart des périthèces examinés n'étaient pas encore à parfaite maturité. Les asques hyalins, ovales à elliptiques, ont 40–70 \times 30–42 μ . Il n'a pas été facile d'observer les spores du fait de l'état de non maturité de beaucoup de périthèces. Les spores sont hyalines, au nombre de 4, parfois 3, dans les asques; nous n'avons pas relevé la présence d'un plus grand nombre; elles sont elliptiques et mesurent 14–23 \times 10–14 μ , en moyenne 19 \times 12 μ (Figures 1 et 2).

Si nous comparons les *Microsphaera* se développant sur les diverses Papilionacées avec le *Microsphaera* de *Spartium junceum*, nous constatons que *Microsphaera astragali* (DC.) Trev. s'attaquant aux *Astragalus* a ses appendices situés dans la



Figure 2
Microsphaera rayssiae sp. nov.
 Asques et spores (Albi, France). $\times 500$.

parties supérieure des périthèces, alors que pour notre parasite, ils sont disposés sur toute leur circonférence; ils sont assez raides et pas plus ou moins mous et flexueux; en outre ils ne sont pas septés, alors qu'ils le sont plusieurs fois et cela dès la base souvent chez *M. astragali*. Les dichotomies sont au nombre de 1 à 3, tandis que pour notre espèce elles sont de 1 à 5, le plus souvent de 3 à 5 et les ramifications terminales sont très variables de forme et de grandeur. Chez les deux parasites, les dichotomies ne se manifestent pas facilement et bien souvent il faut examiner plusieurs périthèces pour les mettre nettement en évidence et encore chez *M. astragali* il arrive assez fréquemment qu'on ne puisse pas en distinguer, tandis que chez *Spartium junceum* on finit toujours par trouver des appendices brisés dans les préparations, qui portent à leur extrémité des dichotomies.

Microsphaera baeumleri Magnus, se développant sur les *Vicia*, a des appendices en touffes et généralement dirigés vers le haut; ils sont plusieurs fois cloisonnés, alors que chez notre parasite ils ne sont pas septés et divergent dans tous les sens. Comme chez *M. astragali*, les dichotomies sont au nombre de 1 à 3 et les dernières ramifications ne sont pas recourbées; c'est le cas pour les ramifications de notre espèce, mais par contre elle présente de 1 à 5 dichotomies, le plus souvent de 3 à 5. Chez *M. baeumleri*, les dichotomies se manifestent très facilement à l'extrémité des appendices, alors que pour notre parasite, de même que chez *M. astragali*, elles sont toujours difficiles à mettre en évidence. Les spores, chez *M. astragali* et *M. baeumleri* sont au nombre de 2-6 dans les asques, le plus souvent respectivement 3-4 et 3-5; pour ce qui concerne notre espèce nous avons constaté la présence, dans les asques, de 4 spores, parfois 3 seulement, mais jamais jusqu'à 6 spores. *M. astragali*

gali et *M. baeumleri* sont évidemment, comme le relève Blumer (1933) et d'autres auteurs, des espèces très voisines l'une de l'autre.

Microsphaera guarinonii Briosi et Cavara, s'attaquant aux *Cytisus* et *Laburnum* a ses périthèces formés de grandes cellules mesurant jusqu'à 25 μ , alors que chez *Spartium junceum* elles ont de 10 à 18 μ . Les appendices sont hyalins et pas souvent plus ou moins brunâtres à leur base; ils ne sont pas cloisonnés, ce qui est aussi le cas dans notre espèce. Les dichotomies sont au nombre de 2 à 4 et les dernières ramifications sont toujours révolutées, ce qui n'est jamais le cas pour notre parasite où les dernières ramifications, quand il y en a, sont de simples protubérances arrondies ou de vagues fourches arrondies à leur extrémité et jamais plus ou moins en pointe, ni surtout recourbées. Le nombre des asques est pareil, 4 à 8; quant au nombre des spores dans les asques, il est de 4-6, le plus souvent 5, alors que chez *Spartium junceum* ce nombre est de 4, rarement 3 et nous n'avons pas vu des asques contenant 5 à 6 spores.

Enfin *Microsphaera coluteae* Komarov, sur les *Colutea* et *Astragalus*, a des appendices en plus grand nombre, 10 à 30; ils se terminent par 2-4 dichotomies dont les dernières ramifications se recourbent, comme chez *M. guarinonii*; nous venons de voir que ce n'est jamais le cas pour notre parasite. Les asques sont nombreux, jusqu'à 20, alors que nous n'en avons pas vu plus de 7 chez *Spartium junceum*. Enfin les spores sont au nombre de 2 à 6, chez notre espèce leur nombre est de 4 ou rarement 3.

Il résulte de cette étude critique des *Microsphaera* s'attaquant aux Papilionacées, que si notre *Microsphaera* de *Spartium junceum* ressemble, par certains caractères, à l'une ou à l'autre de ces quatre espèces, par contre il s'en distingue par d'autres caractères pour le moins aussi importants que ceux justifiant le maintien de ces diverses espèces, qui toutes ensemble constituent évidemment un groupe bien caractérisé dans le genre *Microsphaera*.

Pour toutes les raisons mentionnés ci-dessus, il nous paraît nécessaire de séparer notre parasite des autres espèces déjà observées sur des Papilionacées et nous proposons de lui donner le nom de *Microsphaera rayssiae*, en hommage à Mademoiselle Rayss qui célèbre cette année un bel anniversaire et en témoignage d'admiration pour toute son oeuvre scientifique, en souhaitant que de nombreuses années encore elle puisse continuer ses recherches si fructueuses et si enrichissantes pour la botanique et plus particulièrement pour la mycologie. La diagnose latine de cette nouvelle espèce s'établit de la manière suivante.

***Microsphaera rayssiae* sp. nov.**

Mycelio densissimo, in caulibus et foliis, albo-griseo. *Conidiis* hyalinis, ellipsoideis vel caduformibus, 23-40 \times 12-19 μ , fere 26-33 \times 14-16 μ , medio 30 \times 14 μ . *Peritheciis* numerosissimis, in foliis caulibusque, atris vel atro-brunneis, sphaeroideis, 87-150 μ diam., fere 106-117 μ . *Fulcris* 10-20, hyalinis vel interdum subhyalinis et pallide brunneolis ad basim, aseptatis, usque 950 μ vel 1350 μ longis, 7-9 μ latis ad basim

et 6–8 μ in parte media. Ad apicem 1–5 ies dichotome ramosis, irregularibus, plus minusve rotundatis, saepe furcis terminalibus rotundatis sed non aculeatis nec revolutis, 6–7 μ latis in parte inferiore et 4–5 μ in furcis terminalibus. *Ascis* hyalinis 2–8, ovalibus vel ellipsoideis, 40–70 x 30–45 μ . *Sporis* 4 in ascis, interdum 3, hyalinis, ellipsoideis, 14–23 x 10–16 μ , fere 16–19 x 12–14 μ , medio 19 x 12–14 μ .

Hab. in caulibus foliisque vivis *Spartii juncei* L. in Gallia et Helvetia.

Il est évident qu'une étude biologique de *Microsphaera rayssiae* serait très utile en vue de confirmer expérimentalement les données morphologiques exposées ci-dessus. Nous espérons pouvoir réaliser ces recherches, si les conditions veulent bien s'y prêter. Mais encore pour cela sera-t-il nécessaire de se procurer le matériel d'expérience indispensable, ce qui reste quelque peu aléatoire, le buisson de *Spartium junceum* contaminé se trouvant au bord d'un chemin assez fréquenté et risquant d'avoir été extirpé du fait de sa déformation très considérable provoquée par une fasciation.

A trois endroits, en Suisse romande, il a été observé un *Oidium* sur *Spartium junceum*. Nous l'avons constaté le 14 juin 1952 sur une plante à Lausanne (canton de Vaud), dans le Jardin botanique de l'Université; le 5 août 1954, le professeur Cruchet a récolté cet *Oidium* à Préverenges près de Morges (canton de Vaud): enfin en septembre et octobre 1954, nous l'avons vu dans un jardin public à Neuchâtel. Aux deux premières localités, il n'a été relevé que la présence d'un *Oidium*, sans développement des périthèces. Dans ces conditions, il est difficile de savoir exactement s'il s'agit de *Microsphaera rayssiae* ou de l'*Erysiphe martii* qui a été signalé sur *Spartium junceum*, en France notamment, d'après les renseignements que nous devons à l'obligeance du professeur Viennot-Bourgin de Paris. L'*Oidium* observé à Neuchâtel a été mentionné en 1958 sous le nom d'*Erysiphe martii* (Mayor 1958, p. 68). Ayant relevé sur nos échantillons la présence d'un certain nombre de périthèces, il nous a paru utile de reprendre l'étude de ce parasite à la lumière des observations faites en 1959 dans le Tarn (France).

Aux trois endroits de la Suisse romande où cet *Oidium* a été constaté, le mycelium est diffus et ne constitue pas une croûte comme on l'observe sur les échantillons de France; il recouvre tout ou partie des feuilles, formant un feutrage blanc et assez peu dense; il n'a pas été relevé sur les tiges. Par ailleurs l'infection à Neuchâtel était relativement discrète, n'intéressant pas toutes les feuilles de l'arbuste contaminé, mais un certain nombre seulement.

Les périthèces sont noirs à la loupe, noirs ou d'un brun foncé au microscope, sphériques, 100–140 μ de diamètre, en moyenne 117 μ . Les cellules constituant les périthèces ne s'individualisent à peu près bien qu'après écrasement des périthèces; elles mesurent de 12–18 μ . Les appendices au nombre de 10–20, rarement moins ou davantage, sont hyalins, assez souvent subhyalins ou brunâtres à leur base, non septés, assez fragiles et se brisant facilement; ils sont plus ou moins régulièrement répartis sur toute la circonférence des périthèces; leur largeur est de 7–9 μ à leur base et de 5–7 μ dans la partie moyenne; quant à leur longueur, elle est variable du



Figure 3
Microsphaera rayssiae sp. nov.
 Dichotomies des appendices (Neuchâtel) $\times 500$.

fait de leur fragilité, mais en général ils ont de 600–1000 μ et nous en avons mesuré atteignant 1300–1350 μ .

Sur plusieurs périthèces nous avons constaté que des appendices se terminent parfois, mais pas régulièrement, en dichotomies au nombre de 1–3. Il s'agit soit d'une simple sorte de fourche se terminant par deux protubérances arrondies, ou bien ce sont 2–3 dichotomies très irrégulières de forme et de grandeur, non divisées à leur extrémité ou se terminant par deux protubérances arrondies, jamais plus ou moins en pointe, ni recourbées. L'épaisseur de l'appendice au niveau de la première dichotomie est de 5–6 μ et de 4–5 μ dans les ramifications terminales. Les périthèces renferment 2–8 asques hyalins, ovales à elliptiques, 44–66 \times 39–45 μ . Les spores hyalines sont au nombre de 4 dans les asques, parfois 3; elles sont elliptiques et mesurent 14–23 \times 12–16 μ , le plus souvent 16–19 \times 12–14 μ , en moyenne 19 \times 14 μ (Figures 3 et 4).

Le parasite observé à Neuchâtel se trouve parfaitement assimilable à celui récolté aux environs d'Albi (France), comme on peut le voir en comparant les deux diagnoses ci-dessus. Les dimensions des périthèces sont les mêmes, le nombre et l'aspect des appendices sont pareils. Si nous avons pu mesurer des appendices dépassant 1100 μ de longueur, sur les échantillons de Neuchâtel, c'est qu'ils se brisent moins facilement du fait d'un mycelium ne formant pas une croûte épaisse dans

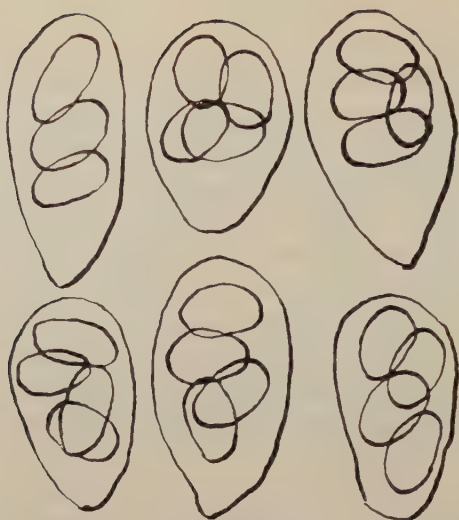


Figure 4

Microsphaera rayssiae sp. nov.
Asques et spores (Neuchâtel). $\times 500$.

laquelle sont enfoncés les périthèces. Pour les deux parasites les dichotomies ont la même apparence irrégulière; si pour les exemplaires de Neuchâtel elles sont au nombre de 1-3 seulement et pas de 1-5, cela peut provenir simplement du fait que nous avons à notre disposition, en vue de leur examen, un nombre relativement restreint de périthèces. Pour les deux parasites, les dichotomies ne se manifestent pas sur tous les appendices; on ne les constate souvent pas sur plusieurs périthèces et nous n'avons pas vu plus de 1 ou 2 appendices terminés en dichotomies sur un même périthèce, qui en présente en général de 10-20. Sur le *Microsphaera* de Neuchâtel, nous avons mesuré un appendice adhérent au périthèces et terminé par 3 dichotomies, qui avait 1350 μ de longueur. Les asques, 2-8 (2-7 pour le parasite du Tarn), sont semblables et il en est de même pour les spores qui sont au nombre de 4, parfois 3 dans les asques.

En résumé, il est évident que le *Microsphaera rayssiae* récolté dans le Tarn (France) est identique au *Microsphaera* observé à Neuchâtel, qui doit donc être rapporté lui aussi à *M. rayssiae*. Ainsi cet intéressant parasite se rencontre aussi bien en France qu'en Suisse. Quant aux deux autres endroits où *Spartium junceum* a été constaté, en Suisse, contaminé par un *Oidium*, il est probable qu'il s'agit également de *M. rayssiae*, sans qu'il soit cependant possible de l'affirmer en l'absence des périthèces qui permettraient de lever tous les doutes.

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RAMULARIA LEAF SPOT OF SAFFLOWER IN ISRAEL

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Leaf spot of safflower, *Carthamus tinctorius* L., caused by *Ramularia carthami* Zaprometoff (1926) is a fairly destructive disease in Israel.

The fungus attacks plants towards the middle or end of their growing period. Lower leaves show the first symptoms of disease. The fungus causes greyish-chest-



Figure 1

nut, rounded or irregular spots, 2–10 mm (occasionally 15 mm) in diameter. Sometimes the spots coalesce and occupy a relatively large area of leaf (Figure 1) thus hastening leaf withering and causing appreciable injury to the plant.

Frequently, rusts (Minz 1958) — the second important disease of safflower — occur simultaneously with *Ramularia*. In the competition for space on the leaf,

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development of rust is hindered by the relatively large area occupied by dry spots of *Ramularia*. Detached and even dry leaves infected with *R. carthami*, when kept in a moist chamber, will sporulate abundantly.

DESCRIPTION OF *Ramularia carthami* ZAPROMETOFF

Tufts of hyaline conidiophores with hyaline conidia are visible on the spots, usually on the underside of the leaf. Conidiophores are simple, measuring $19\text{--}38 \times 3\text{--}4 \mu$, mean $30 \times 3.5 \mu$. Conidia arise, sometimes in short chains, at the apex of the conidiophore; they are cylindrical, rounded at both ends, and slightly constricted at the septa. They are 1–3 septate, measuring $20\text{--}34 \times 2.5\text{--}4 \mu$.

Zaprometoff (1926), in describing this fungus for the first time, stresses the rarity of conidia having more than two septa. His measurements were: $14\text{--}25 \times 3.5\text{--}4.5 \mu$.

Darpoux (1945) on the other hand, described *R. carthamicola*, a similar fungus, with 1–3, and rarely 4-septate conidia. His measurements were $15\text{--}30 \times 2\text{--}4 \mu$.

This disease is found in Israel throughout the country, from the Negev to Galilee. *R. carthami* has been reported in France (Darpoux 1946), India (Mohanty and Das 1958) and Russia (Zaprometoff 1926).

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CI AVICEPS CYNODONTIS IN ISRAEL

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Both honey dew and sclerotia of ergot were encountered on Bermuda grass, *Cynodon dactylon* (L.) Pers., on December 28, 1959, at Nir Banim (southern Israel). The grass was growing on the border of a tomato field which had been irrigated in summer and autumn. Abundant volunteer wheat and barley plants in various stages of development were present in the immediate vicinity, but these were not infected by ergot. Additional samples were collected ten days later on Bermuda grass, but none could be found on the volunteer cereals which remained free of disease until maturity.



Figure 1

As in a previous study on the pathogenicity of ergot from grasses to cultivated wheat (Minz, Gerechter and Avizohar-Hershenson 1960), the infectability of wheat with ergot obtained from Bermuda grass was tested in the greenhouse. Wheat,

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of the variety Thew, was inoculated with a conidial spore suspension obtained from cultured sclerotia on March 15, 1960, and again on March 21. In addition to wheat we also inoculated the grass *Phalaris minor* Retz., which had proved to be susceptible to *Claviceps purpurea* (Fr.) Tul. in our previous experiments. None of the inoculated plants, which were kept until maturity, became infected.

Microscopical examination of the spores revealed hyaline reniform conidia of *C. cynodontis* Langdon, somewhat larger than those described by Grasso (1957).

Bermuda grass is known to be a host of both *C. purpurea* (Grasso 1954) and *C. cynodontis* (Grasso 1957, Langdon 1954).

The occurrence of *C. cynodontis* is known from South Africa, the Gold Coast, India and Nyassaland (Langdon 1954).

This is the first record of the fungus in Israel.

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COMPARAISON DES POUVOIRS FONGICIDES DE QUELQUES DERIVES MINERAUX ET ORGANIQUES DU BORE

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RESUME

La comparaison des pouvoirs fongicides de l'acide borique, du borax et du pentabor d'une part, de deux borolactates d'autre part prouve l'importance de la concentration en ion borique dans l'activité fongicide de ces corps. Diverses techniques sont brièvement décrites: l'inhibition de croissance d'une culture de *Penicillium italicum*, le test de mesure de l'action répressive sur la croissance linéaire, l'incorporation du fongicide à un milieu de culture, le test Benlloch d'essai pour la protection des agrumes.

ABSTRACT

The comparison of the fungicidal power of boric acid, borax and pentabor on one hand and of two borolactates on the other proves the importance of the concentration of the boric ion for the fungicidal activity of these substances. Various methods are described briefly: growth inhibition of a *Penicillium italicum* culture, measurement-tests of the repressive influence on linear growth, incorporation of the fungicide in the culture medium, Benlloch test for citrus protection.

Les dérivés minéraux du Bore sont connus depuis longtemps pour leurs propriétés antiseptiques; leur domaine d'activité est cependant assez restreint du fait de leur faible solubilité dans l'eau à la température ordinaire. L'obtention récente de complexes organoboriques a permis d'augmenter considérablement la concentration en ion borique des solutions préparées même à 20°C.

Par des techniques de laboratoire que nous avons mises au point au cours des dernières années, (Moreau C. et Moreau M., 1959) nous envisagerons l'étude du pouvoir fongicide de trois dérivés minéraux puis de deux dérivés organiques du Bore.

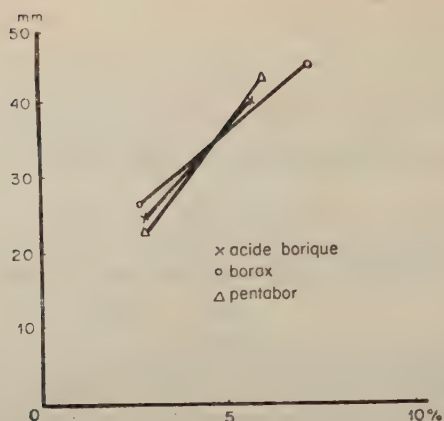
DERIVES MINERAUX

Nos essais ont porté sur l'acide borique, $B_2O_3 \cdot 3H_2O$, le borax (tétraborate de Sodium), $2B_2O_3 \cdot Na_2O \cdot 10H_2O$, le pentabor (pentaborate de Sodium), $5B_2O_3 \cdot Na_2O \cdot 10H_2O$.

I. Inhibition de croissance du *Penicillium italicum*

Les dérivés du Bore étant largement utilisés pour lutter contre le développement des altérations fongiques des agrumes au cours des transports ou en entrepôt, il était normal que nous choissions le *Penicillium italicum* Wehmer, agent de la "moisissure bleue" des oranges, comme Champignon-test.

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Graphique 1

Diamètre des zones d'inhibition de croissance du *Penicillium italicum* en présence de diverses concentrations d'acide borique, de borax et de pentabor exprimées par leur teneur en B_2O_3 .

Technique

Des spores de *Penicillium italicum* sont mises en suspension dans l'eau stérile. Elles sont ensuite pulvérisées d'une manière homogène à la surface d'un milieu de Maltea Moser 1 % gélosé (20g/l) en boîte de Pétri (20cc de milieu par boîte de 100mm de diamètre). Immédiatement après, on dépose au centre de la boîte une goutte de 1/25 cc du fongicide à étudier à la concentration désirée. Le tout est disposé à l'étuve à 25°C pendant 3 jours. De nombreuses colonies de *Penicillium* se développent sauf à l'endroit où la goutte fongicide a été déposée; à ce moment, il suffit de mesurer le diamètre de la zone circulaire dans laquelle le Champignon ne s'est pas développé. Plus la zone d'inhibition est grande et plus le fongicide est actif. On vérifie, bien entendu, que dans les boîtes-témoins n'ayant pas reçu de fongicide, le Champignon s'est développé sur toute la surface du milieu de culture.

Résultats

Nous avons noté les diamètres suivants (en millimètres) des zones circulaires d'inhibition:

Concentration	20%	10%	5%
Acide borique	—	40	25
Borax	45	27	—
Pentabor	—	43	23

A concentrations égales, ces résultats paraissent défavorables au borax. Cependant si l'on tient compte de la teneur en anhydride borique de ces divers corps (56 % pour l'acide borique, 36.5 % pour le borax et 59 % pour le pentabor) et que l'on trace les courbes d'inhibition de croissance on obtient (Graphique 1) 3 droites qui sont pratiquement confondues.

II. Test de mesure de l'action répressive sur la croissance linéaire

Technique

Le processus expérimental a déjà été longuement exposé et discuté (cf. Moreau 1959). Nous le résumerons en précisant les adaptations au cas présent de la technique décrite antérieurement.

Du milieu de Maltea Moser à 1 %, gélifié, est réparti en boîtes de Pétri de 100 mm de diamètre, à raison de 20 cc par boîte. Le Champignon-test est ensemencé juste au centre de la boîte et, à l'étuve à 22°C, forme en 24 heures une colonie circulaire de rayon r_T . A ce moment, on dépose une goutte de 1/25 de cc de la solution fongicide à chacun des sommets d'un triangle équilatéral qui s'inscrirait dans un cercle concentrique à la colonie et de 30 mm de rayon. Les cultures sont ensuite maintenues 2 jours à l'étuve. Les colonies témoins ont alors un rayon R_T . Selon la concentration du fongicide, les cultures présentent divers caractères:

(a) Si son rayon est demeuré égal à r_T , la concentration en contact avec la culture est totalement fongicide.

(b) Si son rayon est égal à R_T , la solution diffusée n'est pas fongicide.

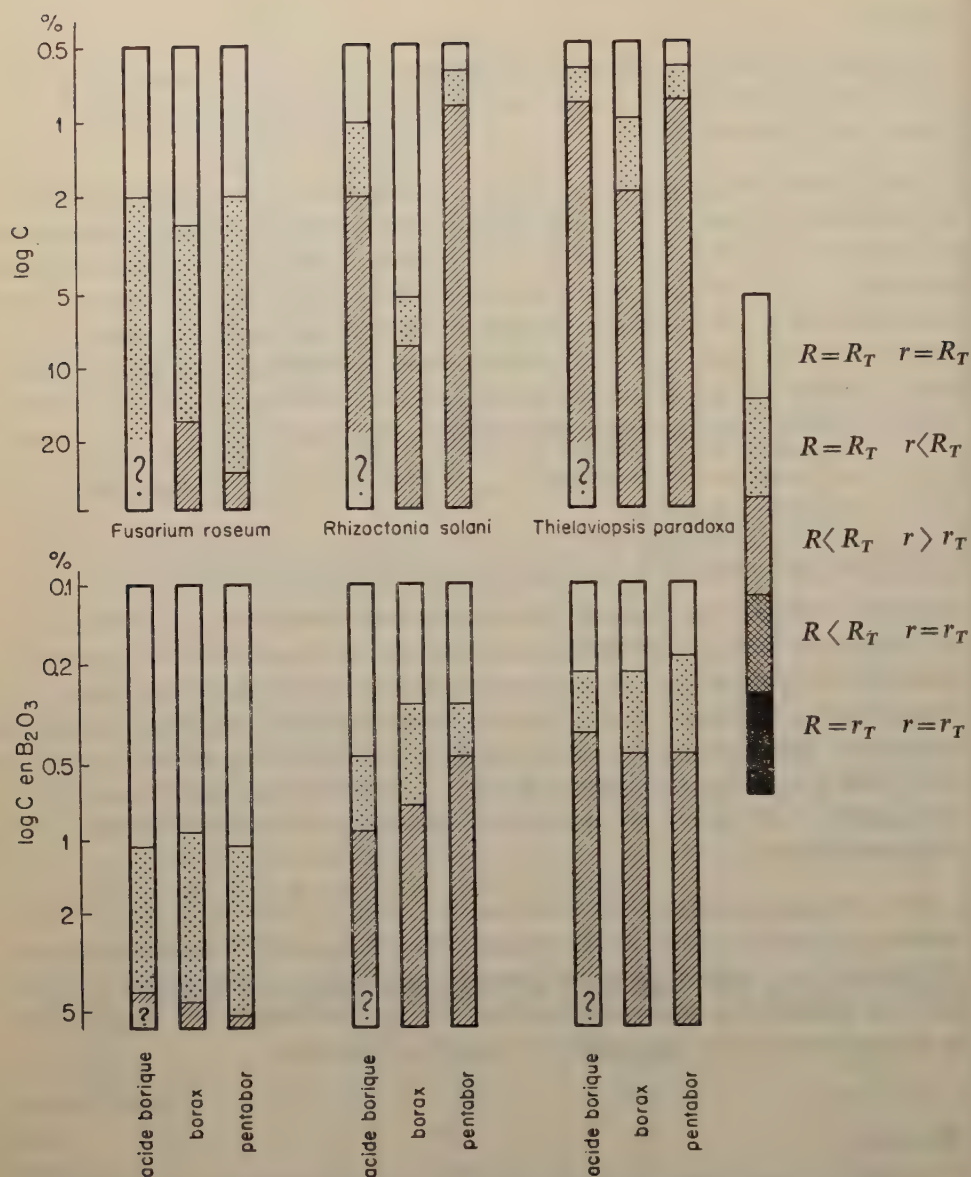
(c) Entre ces deux cas extrêmes, l'évolution de la surface de la colonie permet de définir une zone où le produit est fongicide et une où il est fongistatique. Toute colonie affectée dans sa croissance possède ainsi un rayon R (moyenne de la distance du centre de la boîte aux trois points de croissance maximale) et un rayon r (moyenne de la distance du centre de la boîte aux trois points de croissance minimale). Des graphiques de variation de R et r par rapport aux rayons R_T et r_T des témoins peuvent être dressés en fonction du logarithme de la concentration de la substance étudiée.

Trois Champignons-test ont été choisis: le *Fusarium roseum* (Lk.) Sn. et Hans. f. *culmorum* (W.G.Sm.) Sacc., le *Rhizoctonia solani* Kühn et le *Thielaviopsis paradoxa* (de Seynes) von Höhnelt; ils appartiennent à des groupes systématiques variés, se cultivent aisément au laboratoire où leur croissance est rapide, sont assez faciles à se procurer pour que le test puisse être aisément reproduit.

Résultats

L'influence des dérivés minéraux du bore sur la croissance des Champignons testés peut s'exprimer par le Graphique 2. Là encore, si l'on ramène à la teneur en B_2O_3 des divers dérivés, on constate que, pour un Champignon donné, les diagrammes obtenus sont sensiblement identiques.

Notons la faible toxicité des dérivés du bore vis-à-vis du *Fusarium roseum*, ce que nous avons pu confirmer dans d'autres essais.



Graphique 2

Diagrammes d'inhibition de croissance du *Fusarium roseum*, du *Rhizoctonia solani* et du *Thielaviopsis paradoxa* en présence de diverses concentrations d'acide borique, de borax et de pentabor (en haut), des mêmes concentrations exprimées par leur teneur en B_2O_3 (en bas). A droite: explication des signes conventionnels.

DERIVES ORGANIQUES

Les complexes organo-boriques du type de ceux que nous avons utilisés, sont communément désignés sous le vocable "albotènes" (Cf. Moreau, 1958). Un procédé particulier de fabrication breveté a permis d'augmenter la concentration en acide borique par rapport aux préparations antérieurement connues. Les deux borolactates expérimentés ont respectivement une teneur en acide borique de 10% (BL 10) et de 30% (BL 30).

I. Incorporation à un milieu de culture

Technique

La méthode classique consiste à incorporer à un milieu de culture, avant stérilisation, la substance à étudier à diverses concentrations. Le milieu de culture choisi est le milieu de Maltea Moser 1% gélosé et les borolactates ont été incorporés aux concentrations de 10, 5, 2 et 1%. Sur ces milieux ont été ensemencés en un point les Champignons suivants: *Alternaria tenuis* Nees, *Botrytis cinerea* Pers., *Colletotrichum musae* (Berk. et Curt.) v. Arx, *Fusarium roseum* (Lk) Sn. et Hans. f. *culmorum* (W. G.Sm.) Sacc., *Thielaviopsis paradoxa* (de Seynes) v. Höhn., *Trichothecium roseum* Lk.. Les cultures sont placées à 25°C et leur diamètre est mesuré chaque jour.

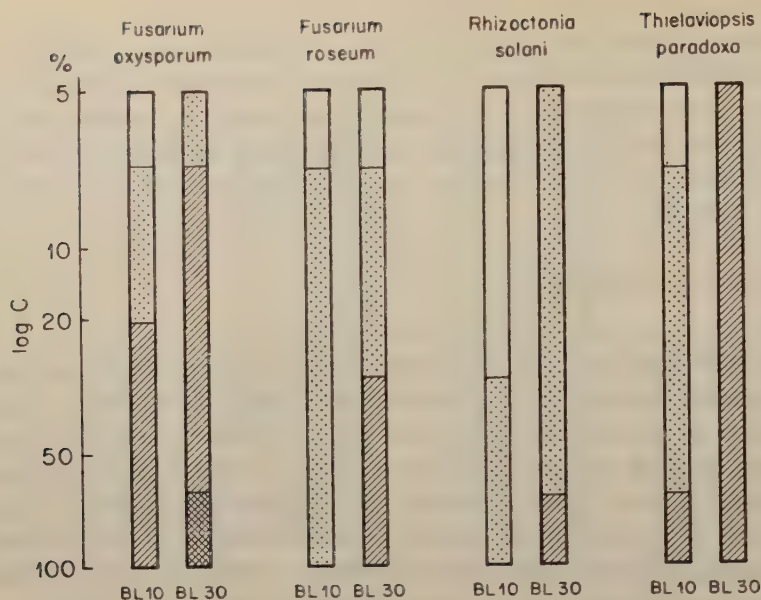
Résultats

A titre indicatif nous donnerons en un tableau le diamètre, exprimé en millimètres, des cultures au 11ème jour, 60 mm correspond au diamètre maximum susceptible d'être mesuré en raison de la taille des récipients de culture.

Concentrations:		10%	5%	2%	1%
<i>Alternaria tenuis</i>	{BL 10	18	50	55	60
	{BL 30	7	18	45	60
<i>Botrytis cinerea</i>	{BL 10	0	0	0	18
	{BL 30	0	0	0	8
<i>Colletotrichum musae</i>	{BL 10	0	16	32	60
	{BL 30	0	0	8	49
<i>Fusarium roseum</i>	{BL 10	50	60	60	60
	{BL 30	0	0	19	34
<i>Thielaviopsis paradoxa</i>	{BL 10	0	0	0	3
	{BL 30	0	0	0	0
<i>Trichothecium roseum</i>	{BL 10	6	13	16	28
	{BL 30	0	0	0	9

Tous les témoins ont un diamètre d'au moins 60 mm.

L'inhibition de croissance par le borolactate à 30% d'acide borique est nettement plus important que celle par celui qui n'a que 10% d'acide borique.



Graphique 3

Diagrammes d'inhibition de croissance du *Fusarium oxysporum*, du *Fusarium roseum*, du *Rhizoctonia solani* et du *Thielaviopsis paradoxa* en présence de diverses concentrations de deux borolactates, l'un (BL 10) correspondant à 10% d'acide borique, l'autre (BL 30) à 30%.

II. Test de mesure de l'action répressive sur la croissance linéaire

Technique

La même technique que celle décrite plus haut a été expérimentée avec les deux borolactates. Outre le *Fusarium roseum* (Lk.) Sn. et Hans., le *Rhizoctonia solani* Kühn et le *Thielaviopsis paradoxa* (de Seynes) von Höhn., notre test a porté sur une souche du *Fusarium oxysporum* (Schl.) Sn. et Hans.

Résultats

Les résultats sont résumés dans le Graphique 3. Le borolactate correspondant à une teneur en acide borique de 30% montre, vis-à-vis des souches testées, une action répressive plus forte que le borolactate à 10% d'acide borique. Cette grande efficacité est particulièrement sensible avec le *Thielaviopsis paradoxa*.

III. Test Benlloch

Technique

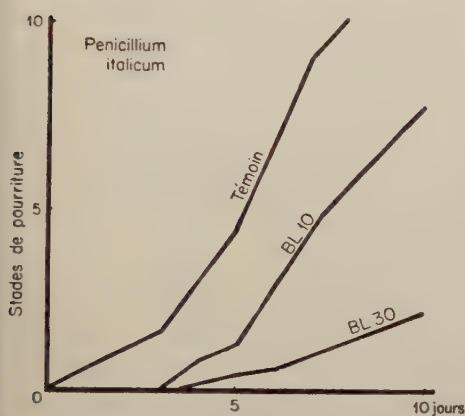
Le test que nous désignons sous le nom test Benlloch est une méthode commode d'essais fongicides pour la protection des agrumes. Nous lui avons déjà consacré une étude (Moreau 1959).

Des scarifications en quadrillage sont pratiquées à la surface d'oranges puis celles-ci sont immergées dans les solutions fongicides à tester. Après séchage des fruits

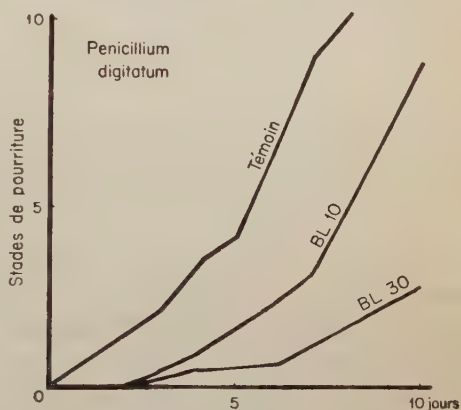
une suspension de spores de *Penicillium italicum* ou de *Penicillium digitatum* est pulvérisées à la surface des oranges traitées et l'évolution des pourritures à 20°C est examinée en comparaison avec celle des fruits témoins non traités. Nous avons défini des stades de pourriture cotés de 0 à 10. En fonction de la durée de conservation des fruits, il est possible d'établir ainsi une courbe d'évolution des pourritures.

Résultats

L'examen comparatif de l'évolution des pourritures à *Penicillium italicum* et *Penicillium digitatum* en présence des borolactates BL 10 et BL 30 à la concentration de 3% est résumé par les Graphiques 4 et 5.



Graphique 4



Graphique 5

Evolution des pourritures à *Penicillium italicum* dans le test Benlloch en présence de deux borolactates BL 10 et BL 30 à la concentration de 3%.

Evolution des pourritures à *Penicillium digitatum* dans le test Benlloch en présence de deux borolactates BL 10 et BL 30 à la concentration de 3%.

Dans tous les cas, l'action inhibitrice du borolactate à 30% d'acide borique est nettement plus élevée que celle du borolactate à 10% d'acide borique. Si l'on utilise dans la pratique une concentration plus élevée (5%) de borolactate à 30% d'acide borique on obtient une inhibition totale du développement des pourritures.

CONCLUSIONS

La teneur en ion borique des dérivés minéraux et organiques du Bore que nous avons expérimentés apparaît comme étant le facteur essentiel agissant sur le pouvoir fongicide de ces composés. La faible activité des composés minéraux de l'acide borique semble surtout venir de leur faible solubilité.

Nous remercions M. P. Varchon pour l'assistance technique qu'il nous a apportée dans la réalisation d'une partie des essais exposés dans cette note.

La possibilité de solubiliser l'acide borique permettant d'obtenir à la température ordinaire des concentrations en ion borique plus élevées rend particulièrement intéressante l'utilisation des complexes organiques tels que les borolactates dont nous avons mis en évidence le pouvoir fongicide.

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UNE ALTERATION DES ARTICHAUTS

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ABSTRACT

Previous attacks of *Bremia lactucae* on artichokes and certain storage conditions seem to favourise the subsequent *Botrytis cinerea* rot and the parasitism of *Ascochyta hortorum*. The abundant mass conidia production of *Fusarium roseum* and the spreading out of numerous saprophytes disguise sometimes the deterioration caused by the precedent fungi.

RESUME

Les attaques primaires du *Bremia lactucae* et certaines conditions d'entreposage paraissent favoriser chez des artichauts une pourriture à *Botrytis cinerea* et le parasitisme de l'*Ascochyta hortorum*. L'abondante efflorescence du *Fusarium roseum* et le développement de nombreux saprophytes masquent parfois les altérations fongiques qui les précèdent.

La culture de l'artichaut (*Cynara scolymus*) prend, dans le Midi de la France, une grande extension. Pour échelonner les ventes on a tenté la conservation des capitules en sacs de polyéthylène. Des altérations variées sont apparues au cours de l'entreposage et, ayant examiné divers échantillons provenant de cultures en sol très humide, fraîchement récoltés ou après plusieurs mois de stockage au froid ou à la température ambiante, il nous a été possible de dresser l'inventaire des Champignons rencontrés et d'envisager le mode d'infestation et la gravité des attaques propres à chacun d'eux.

Nous avons noté plusieurs types d'évolution de la microflore fongique des artichauts et nous avons pu reproduire, disposant les capitules en chambre chaude et humide, la succession des agents d'altération.

Souvent, à la face interne des bractées basales, on observe des taches rosées: à la coupe, l'examen révèle la présence dans les tissus d'un mycélium hyalin, de fort diamètre, non cloisonné. Les efflorescences obtenues à la surface permettent de préciser qu'il s'agit du *Bremia lactucae* Regel, connu comme responsable du "mildiou de l'artichaut". Quand le développement de ce Champignon est peu intense et qu'un petit nombre de bractées est atteint, il peut passer inaperçu. Les tissus très tendres gorgés d'eau, peu lignifiés, à épiderme fragile des artichauts obtenus dans de telles cultures sont facilement la proie de ce parasite. Un *Verticillium* s'installe très tôt en hyperparasite. L'action traumatisante du *Bremia lactucae* qui se développe dès la plantation, avant la cueillette, est déterminante pour le développement ultérieur, en entrepôt des autres agents d'altération.

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Sur les tissus nécrosés par le *Bremia lactucae* apparaissent rapidement plusieurs saprophytes banaux, bons agents cellulolytiques tels que les *Alternaria tenuis* Nees, *A. tenuissima* (Fr.) Wiltsh. et le *Stemphylium botryosum* Wallr. Ils provoquent un agrandissement de la surface nécrosée et l'altération, partie de la région pédonculaire, gagne les bractées internes et supérieures du capitule. D'autres Champignons, *Penicillium* divers, *Cladosporium herbarum* (Pers.) Lk. ne tardent pas à infester les capitules morbides.

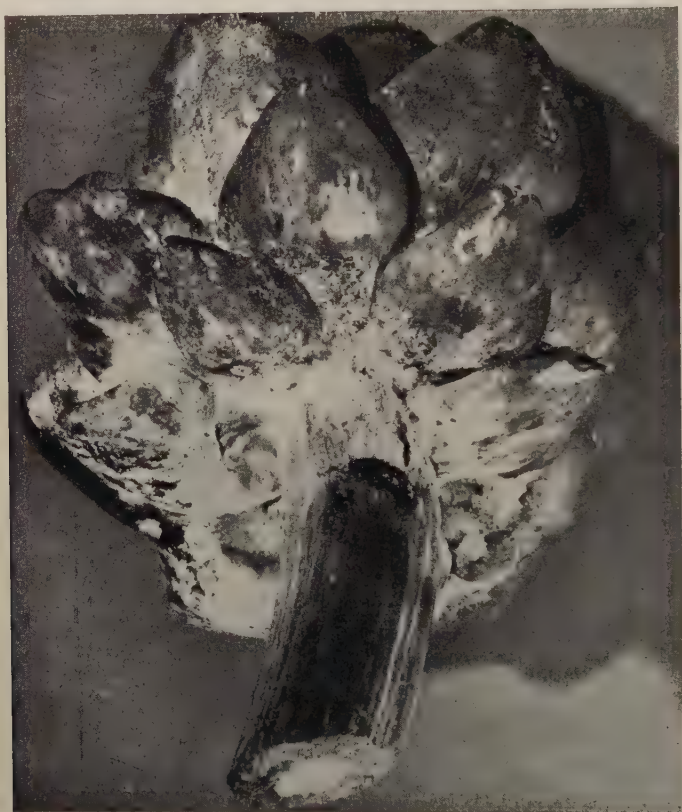


Figure 1

Capitule d'artichaut présentant des altérations fongiques variées (notamment le *Botrytis cinerea* et l'*Ascochyta hortorum*, partiellement masqués par le *Fusarium roseum*).

Cliché R. Haccard

Lorsque les conditions de stockage lui sont favorables, et c'est notamment le cas dans les sacs de polyéthylène clos, d'autres espèces se développent soit à la faveur des attaques primaires de *Bremia*, soit à la suite de traumatismes quelconques. Le plus visible de ces Champignons est incontestablement le *Botrytis cinerea* Pers.:

il pousse souvent avec luxuriance à la base de l'involucre, sur le pédoncule et forme de gros sclérotés noirs. Link *et al.* (1924) ont d'ailleurs déjà souligné l'influence de l'humidité sur le développement du *Botrytis cinerea* sur des artichauts prématurément affaiblis par une gelée. D'autre part on assiste à un brunissement progressif des bractées soit dans le sens ascendant (la pourriture partant d'une bractée pédonculaire rejoint l'involucre, atteint le réceptacle et remonte dans le capitule) soit dans le sens descendant (les nécroses commencent par l'extrémité supérieure des bractées et pénètrent en profondeur jusqu'au réceptacle négligeant souvent les bractées



Figure 2

Bractée parasitée par le *Botrytis cinerea*, qui a formé un bel amas de sclérotés noirs.

Cliché R. Haccard

périphériques qui demeurent apparemment indemnes); ce brunissement est souvent lié à l'*Ascochyta hortorum* (Speg.) Sm., un grave agent pathogène de l'artichaut dont Malençon (1936) a bien décrit le développement; les bractées malades se couvrent de pycnides globuleuses, fructifications du parasite.

Un *Fusarium roseum* (Lk.) Sn. et Hans. accompagne souvent le *Botrytis* et l'*Ascochyta* et peut même dans certains cas prendre une telle extension que ses efflorescences masquent les autres Champignons. Divers saprophytes, *Aspergillus*, *Penicillium*, *Trichothecium roseum* Lk., *Acremoniella atra* Sacc. ont aussi été observés. Aidées de Bactéries, transmises soit par simple contact formant alors des nids infectieux,

soit par les insectes (notamment les Drosophiles), ces diverses espèces fongiques détruisent peu à peu les tissus de l'artichaut. Celui-ci est pourtant capable de réagir au moins dans ses tissus pédonculaires; la présence de cals cicatriciels et d'une intense gommose en sont la preuve.

Il semble logique de penser que la suppression du *Bremia lactucae* par réduction des irrigations et traitements chimiques à la plantation devrait appréciablement réduire les pertes en cours de stockage.

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LES CHAMPIGNONS SONT-ILS DES VEGETAUX OU DES ANIMAUX?

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ABSTRACT

The generally accepted view that the Fungi belong to the vegetable kingdom is a pure convention: there is no general feature which would allow to attach all the Fungi either to plants or to animals. For each group of Fungi separately one has to search after the vegetal or animal origin of the organisms which constitute it. In the present paper the Actinomycetes, the Myxomycetes, the Higher Fungi, the Zygomycetes and the Lower Fungi are discussed successively. Actinomycetes and Myxomycetes kept apart, one can consider the Chytridiales as the common trunk of all the other Fungi. They are themselves archaic forms and derive from colourless Flagellates. Therefore the Fungi may be held as a particular phylum of the animal kingdom.

RESUME

L'attribution courante des Champignons au monde végétal est de pure convention: aucun caractère général ne permet de rattacher aux végétaux oux animaux l'ensemble des Champignons. C'est pour chaque groupe fongique qu'il faut rechercher l'origine végétale ou animale des organismes qui le constituent. Sont successivement examinés: les Actinomycètes, les Myxomycètes, les Champignons supérieurs, les Zygomycètes, les Champignons inférieurs. Actinomycètes et Myxomycètes mis à part, les Chytridiales se présentent comme pouvant être une souche commune à tous les autres Champignons. Ces formes archaïques dérivent elles-mêmes des Flagellés incolores; par ceux-ci les Champignons méritent d'être tenus pour un phylum particulier du règne animal.

Nul ne met en doute, dans le grand public, l'appartenance des Champignons au monde des plantes; suggérer qu'ils puissent être des représentants du règne animal c'est, semble-t-il, vouloir braver l'opinion et affecter une attitude paradoxale.

N'ont-ils pas dès l'abord les caractères les plus apparents des végétaux?

Considérons sur le sol des forêts les organes en forme de coupoles pédicellées qui constituent la partie la plus apparente des Champignons à lames (Amanites, Tricholomes, Agarics, Russules, Lactaires) ou des Bolets; ne rappellent-ils pas, par leur implantation dans l'humus et par leur immobilité, les végétaux authentiques à l'ombre desquels ils se développent? L'aspect frutescent de certaines Clavaires (*Clavaria formosa*, *Cl. botrytis*, *Cl. stricta*, etc.), de même que les ramifications spatulées de quelques Polypores (*Polyporus frondosus*), et aussi la présence à la base de toutes ces productions d'un mycélium filamenteux qui s'enfonce dans le substratum à la manière d'un appareil radical, accentuent encore la ressemblance générale des Champignons et des plantes.

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Mais les hommes de science savent qu'il y a des animaux qui vivent fixés et que, parmi eux, il en est de branchus, comme les Coraux; quand ils donnent à une Clavaire le nom de *Clavaria coralloides*, ils ne veulent que signaler son aspect — celui d'une branche de corail — sans préjuger sa nature animale.

Ils disposent d'autres critères que ceux de la forme pour maintenir les Champignons parmi les végétaux. Ils invoquent en particulier des caractères d'ordre chimique: le meilleur est la présence de cellulose dans la membrane cellulaire de beaucoup de Champignons (Saprolégnales, Péronosporales, Pythiales, Mucorales, Urédinales, etc.), comme dans celle de tous les végétaux supérieurs.

Toutefois il convient de remarquer que la cellulose n'est pas l'apanage exclusif des végétaux; on la rencontre aussi chez des animaux (les Tuniciers). D'autre part, il est intéressant de noter qu'un grand nombre de membranes fongiques renferment de la chitine, un composé azoté étranger aux végétaux indiscutés et très répandu chez des animaux (Vers, Arthropodes, Crustacés). Dans le protoplasme de certains Champignons (filaments de *Mucor* et de *Saprolegnia*, cellules de Levures, asques d'Ascomycètes), on observe de même du glycogène, un produit de réserve qui existe dans le foie de nombreux animaux; mais cette même substance, ou une substance très voisine, se retrouve chez les Algues du groupe des Floridées et chez les Cyanophytes.

Aucun critère d'ordre chimique n'a de valeur absolue pour fixer la place des Champignons dans l'un ou l'autre des deux grands règnes d'êtres vivants.

Si quelques formes végétales (*Orobanche*, *Neottia*, *Cuscuta*, etc.) sont plus ou moins incolores, la plupart des végétaux sont verts. Or les Champignons sont des organismes sans chlorophylle, comme les animaux, et le manque de pigments assimilateurs les rend inaptes à la photosynthèse. Ils sont également dépourvus des plastides si abondants chez les végétaux verts et rares ou absents chez les animaux. Leurs mitochondries, exclusivement du type des mitochondries inactives de Guillemont, les éloignent encore du monde végétal.

La motilité existe quelquefois chez eux: beaucoup connaissent à l'état de spores (*zoospores*) ou de gamètes (*zoogamètes*) une phase au cours de laquelle des flagelles assurent leur déplacement dans l'eau. L'étude de ces flagelles montre que leur histoire est différente de celle des flagelles d'autres végétaux des — Algues en particulier.

Il n'est pas de caractère qui sépare nettement l'ensemble des Champignons de l'ensemble des végétaux ou des animaux.

Il semble raisonnable de penser que les Champignons ne constituent pas un groupe homogène et peuvent réunir des formes aux affinités végétales et d'autres aux affinités animales. Dès lors, c'est pour chaque division du groupe qu'il est nécessaire de rechercher la parenté avec des animaux ou avec des végétaux.

Nous étudierons quelques divisions importantes au sein de chacune desquelles règne une homogénéité assez grande pour qu'on puisse accorder à ses représentants

une origine commune. Nous examinerons successivement les Actinomycètes, les Myxomycètes, les Champignons supérieurs ou Dangeardiomycètes (Ascomycètes et Basidiomycètes), les Zygomycètes (Mucorales et affines), certains Champignons inférieurs et les Chytridiales.

ACTINOMYCETES

Les Traités de Mycologie donnent parfois asile à des microorganismes faits de filaments plus ou moins longs, mais toujours extrêmement ténus—de moins de 1μ de diamètre—, continus, au contenu sensiblement homogène, et paraissant dépourvus de noyaux—au moins de noyaux ordinaires—; ils se désarticulent souvent au sommet et se résolvent dans cette région en fragments qui rappellent des bacilles ou des microcoques; un grand nombre d'entre eux sont pathogènes, comme l'*Actinomyces Israeli* et les Actinomycètes affines, responsables de l'actinomycose de l'homme et du boeuf, ou le *Mycobacterium tuberculosis*, agent de la tuberculose.

De tous ces caractères, beaucoup éloignent les Actinomycètes des Champignons, bien que Vuillemin (1904) leur ait fait une place parmi ces derniers. Plusieurs sont accueillis par les microbiologistes dans le groupe des Bactéries.

Champignons ou Bactéries, il n'y a pas de raisons sérieuses de considérer les Actinomycètes comme des végétaux.

MYXOMYCETES

Les Myxomycètes sont également bien particuliers. Leur protoplasme, longtemps dépourvu de membrane, rampe sur les débris de végétaux pourrissants (vieilles souches, feuilles mortes, tannée), sous la forme d'un plasmode; il offre alors l'aspect d'une lame semi-fluide large comme une ou deux fois la main, et il émet des pseudopodes, qui sont pour lui à la fois des organes de locomotion et des organes préposés à l'ingestion des aliments. Il rappelle ainsi une amibe, mais une amibe géante, pourvue de très nombreux noyaux. On rapporte les amibes au groupe des Rhizopodes et on y voit des animaux microscopiques. A l'état de plasmode, un Myxomycète présente donc les traits d'un animal.

On retrouve ce caractère animal lorsque, le plasmode s'étant transformé en sporanges, il sort de chaque spore une petite masse de protoplasme nu, mobile par deux flagelles inégaux, comme certains Flagellés — qui sont encore des animaux microscopiques.

Le recours à la chimie des membranes, que permet l'étude des spores, révèle que certaines espèces ont des membranes sporaires cellulosiques et sans chitine, alors que d'autres ont des membranes avec chitine et sans cellulose.

Le cycle évolutif, selon les cas, est haplo-, diplo-, ou haplodiplobiontique, comme chez les végétaux, tandis que chez les animaux il est ordinairement diplobiontique. Malgré cette différence et bien que la nature anthracénique de leurs pigments les rapproche des végétaux, nous tiendrons les Myxomycètes comme un groupe spécial doté d'évidentes affinités animales.

CHAMPIGNONS SUPERIEURS

Avec les Ascomycètes et les Basidiomycètes (Pezizes, Agarics, Bolets, etc.) nous avons affaire à des Champignons authentiques.

En principe, ils sont pourvus d'un mycélium étendu, aux filaments cloisonnés, susceptibles de s'enchevêtrer pour former les organes massifs qui représentent la partie la plus visible du Champignon. Ils sont remarquables par la possession d'un appareil sporifère particulier, le dangeardien (qui leur vaut le nom de Dangeardiomycètes), siège d'une caryogamie et d'une méiose, et qui affecte le plus souvent l'aspect d'une baside, aux spores externes, ou celui d'un asque, aux spores internes. La production des ces appareils est ordinairement annoncée par une phase filamenteuse plus ou moins étendue qui constitue un des traits les plus originaux des Champignons supérieurs, et que caractérisent des cellules régulièrement binucléées; elle réalise une dicaryophase, reconnaissable—sans recours aux techniques cytologiques qui révèlent les noyaux—à la présence de boucles latérales ou de crochets terminaux, formations homologues qui président à la division conjuguée des paires de noyaux des cellules de cette partie du cycle évolutif.

L'asque et la baside paraissent n'avoir pas leur équivalent exact hors des Dangeardiomycètes. Le fait qu'une même cellule soit le siège d'une caryogamie que suit immédiatement une méiose se retrouve dans le zygote d'un *Spirogyra* ou celui d'un *Chlamydomonas*, mais les appareils végétatifs de ces Algues vertes n'invitent nullement à les rapprocher des Champignons supérieurs.

Certains mycologues voient dans les Algues rouges des éléments de ressemblance. Ce sont d'abord les appareils reproducteurs des Floridées, d'un *Nemalion* par exemple, qui leur paraissent comparables à ceux des Ascomycètes du genre *Collema*, engagés dans la symbiose lichénique: dans les deux cas, on décrit des gamètes mâles immobiles ou spermaties et des organes femelles qui reçoivent de ces dernières une fécondation par l'intermédiaire d'un trichogyne. Toutefois le trichogyne des *Nemalion* est un simple diverticule de l'oogone, tandis que celui des *Collema* est filamenteux et pluricellulaire; d'autre part, le prétendu organe femelle des *Collema* est un filament pelotonné, et la recherche des phénomènes nucléaires de la fécondation, fructueuse chez les *Nemalion*, est restée vaine à son niveau chez les *Collema*. L'observation des structures réputées sexuelles des *Collema* ne constitue donc pas une base sûre pour reconnaître une parenté entre les Ascomycètes et les Floridées.

Un argument différent emprunté aux caractères de l'appareil végétatif est impressionnant: Chadeffaud (1953) a eu l'idée de comparer les bourgeons anastomotiques observés chez les Floridées aux anses latérales des mycéliums bouclés des Champignons supérieurs. Si les bourgeons anastomotiques paraissaient liés à un état régulièrement binucléé des filaments des Algues qui les montrent, comme c'est généralement le cas des boucles chez les Champignons, on n'hésiterait sans doute pas à proclamer l'homologie des deux formations; le fait que les boucles et les bourgeons anastomotiques relèvent de tronçons du développement différents n'est pas sans enlever à l'ingénieuse comparaison de Chadeffaud une part de sa valeur indicatrice de liens phylétiques étroits entre les deux groupes.

En fait, les intermédiaires manquent entre les Floridées et les Champignons supérieurs, et nous ne soupçonnons pas quels sont parmi ces derniers ceux qui offriraient de convaincantes affinités floridéennes.

ZYGOMYCETES

Les Mucorales et groupes affines (Endogonales et Entomophthorales) constituent les Zygomycètes, que caractérisent une structure le plus ordinairement multinucléée, une reproduction asexuelle par des spores immobiles et une reproduction sexuelle qui comporte une conjugaison de compartiments du thalle. Ceux-ci sont en principe plurinucléés; on leur accorde alors la valeur de gamétanges, et leur fusion est une gamétangie. Lorsque les compartiments du thalle sont uninucléés—cas assez exceptionnel de certaines Entomophthorales, aux cellules végétatives uninucléées—, c'est à une hologamie que se rapporte la formation des zygotes.

Si nous recherchons parmi les Algues des organismes dont les traits rappellent les précédents, nous pouvons être tentés de fixer notre attention sur les Algues Conjuguées, dont les zygotes résultent aussi de la fusion de compartiments du thalle. Ces compartiments sont uninucléés; leur fusion est donc une hologamie; ceci éloigne les Conjuguées de la grande majorité des Zygomycètes—où la règle est une gamétangie.

La confrontation des Mucorales, ou des Endogonales, avec les *Vaucheria*—qui sont des Algues Siphonées—montre un thalle cénocytique dans les deux cas et des gamétanges jeunes multinucléés. (Les gamétanges des Endogonales présentent de singuliers phénomènes de migration de noyaux qui rappellent les migrations qui ont été décrites dans le jeune gamétange femelle des *Vaucheria*). Cependant il n'y a pas de copulation des gamétanges chez les *Vaucheria*: le gamétange femelle demeure indivis et le gamétange mâle libre des anthérozoïdes biflagellés. On ne peut, par suite, considérer les *Mucor* ou les formes voisines comme des *Vaucheria* qui auraient perdu leurs chloroplastes.

Une ascendance directe des Zygomycètes aux dépens des Algues est difficile à défendre.

CHAMPIGNONS INFÉRIEURS

Le phylum des Champignons inférieurs qui réunit les Blastocladales, les Monoblépharidales, les Saprologéniales et les Péronosporales possède aussi des représentants dont certains caractères rappellent ceux des *Vaucheria*: dans les termes les plus élevés de la série, la structure cénocytique est répandue et les gamétanges y naissent en général plurinucléés.

Les Blastocladales et les Monoblépharidales ont un mycélium peu développé; leur reproduction asexuelle est assurée par des zoospores et leur reproduction sexuelle par des zoogamètes. Au niveau des Saprologéniales s'introduit la perte de l'individualisation des spores et celle de l'individualisation des gamètes: les zoogamètes mâles disparaissent. Chez les Péronosporales aucun des deux gamétanges ne sépare de gamètes et la gamétangie est réalisée.

Or nous savons que dans les *Vaucheria* le gamétange femelle ne divise pas son contenu, contrairement à ce qui a lieu chez les Saprologéniales; c'est le gamétange mâle qui fournit des zoogamètes; il paraît donc désirable de chercher ailleurs l'origine des Champignons inférieurs.

Il existe des organismes très primitifs auxquels plus aisément qu'à des Algues se laisse rattacher l'ensemble des Champignons: ce sont les Chytridiales (Dangeard, 1886).

Les Chytridiales forment un groupe composite varié.

Leur corps, le plus souvent arrondi, s'allonge parfois en un mycélium rudimentaire, et elles produisent fréquemment des cellules mobiles: zoospores et zoogamètes. Chez beaucoup de Chytridiales, ces cellules se meuvent par un flagelle unique, postérieur; chez d'autres, elles se déplacent par un flagelle antérieur; certaines sont munies de deux flagelles, apicaux ou latéraux; il en est enfin qui sont sans flagelles. La reproduction sexuelle s'y fait par la fusion de zoogamètes, mais la gamétangie est aussi réalisée, ainsi que l'hologamie.

Cette diversité est intéressante pour le phylogéniste, qui y trouve une raison de tenir le groupe qui la présente pour un groupe archaïque, aux caractères simples, mais un groupe nodal, dont les diverses divisions ont pu engendrer autant de phylums distincts.

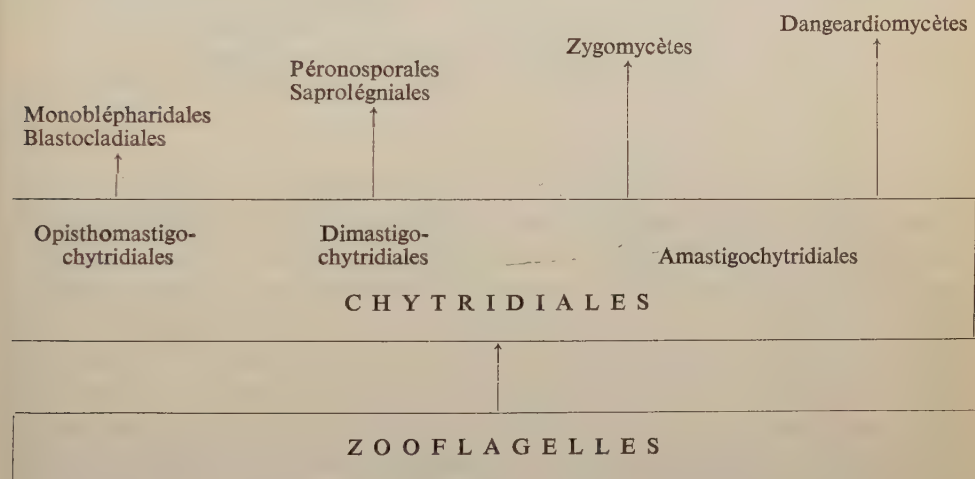
Les Chytridiales à un flagelle postérieur, ou Opisthomastigochytridiales (*ὀπίσθιος*, postérieur; *μάστιξ*, fouet), sont la souche très probable des Champignons à zoospores et zoogamètes uniflagellés à l'arrière, ou Opisthomastigomycètes: Blastocladales, Monoblépharidales. (La disposition du flagelle à l'avant ne se rencontre pas chez les Champignons).

Les Chytridiales biflagellées, ou Dimastigochytridiales, paraissent conduire aux Diamastigomycètes, à spores ou gamètes à deux flagelles: Saprologéniales, Péronosporales.

Et aux Chytridiales immobiles, ou Amastigochytridiales, semblent correspondre les Champignons sans flagelles, ou Amastigomycètes: Zygomycètes et Dangeardiomycètes.

Le tableau ci-après (Moreau, 1952-53) met de tels rapports en évidence. Il n'y figure que des Champignons authentiques; les groupes marginaux—Actinomycètes et Myxomycètes—ont été écartés.

Ainsi conçue, l'évolution chez les Champignons procède par rameaux parallèles: certains s'arrêtent après avoir atteint un degré de complexité ou de perfectionnement que d'autres franchissent. Des vues analogues ont été présentées par P. Bertrand chez les Plantes vasculaires; elles pourraient sans doute être développées à l'occasion d'autres grands groupes d'êtres vivants; l'évolution parallèle des rameaux phylétiques paraît susceptible d'être érigée en une loi générale de la phylogénie.



L'origine des Champignons authentiques étant placée dans les Chytridiales, il est intéressant de noter les ressemblances qui existent entre les Chytridiales et les Protozoaires flagellés; elles n'en diffèrent que par le mode de nutrition—superficiel—, comme l'a indiqué autrefois P. A. Dangeard.

Ces mêmes Flagellés et beaucoup d'Algues inférieures unicellulaires (Phytoflagellés) paraissent avoir une souche commune, qui constitue un lien phylétique lointain entre les Algues et les Champignons; mais il ne semble pas que la décoloration des Algues, phénomène isolé, accidentel, ait donné directement naissance à aucun groupe fongique étendu. Les Champignons se rattachent aux Zooflagellés d'une manière plus évidente; les plus archaïques d'entre eux montrent avec certains Protozoaires des rapports étroits; nous dirons qu'ils méritent d'être considérés comme un phylum particulier du règne animal.

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UN *PENICILLIUM* INTERESSANT DES SABLES LITTORAUX AU LIBAN

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ABSTRACT

A *Penicillium* of the *nigricans* series has been isolated from the sand of the beach near Beirut. Particulars are given on the development of the spore chains; the fertile cells of the penicillus are true phialides and the conidium formation follows the same pattern as in *P. tardum* Thom.

This species is tentatively assigned to *P. megasporum* Orpurt and Fennel, a characteristic member of the mycoflora of some grassland soils in the U.S.A.

A deux reprises, en décembre 1958 et en janvier 1960, la Station Agronomique Libano-Française de Tel-Amara (Liban) nous a adressé quelques échantillons de sable récolté sur la plage au S. de Khaldi, sur le rivage méditerranéen proche de Beyrouth. A notre demande, les prélèvements ont été effectués à des distances croissantes du rivage, en surface et à des profondeurs de 10 et 20 cm. Les relevés les plus caractéristiques ont été obtenus à partir du matériel récolté à environ 20 mètres de la mer, dans le sable vif dépourvu de végétation; c'est un sable à grain fin, de couleur claire en surface, mais imprégné d'oxyde de fer et coloré en ocre rouge dans la profondeur. La microflore fongique est dominée par de nombreuses espèces d'*Aspergillus*, dont beaucoup sont ascosporeées, et par des *Penicillium* variés. La liste complète en est publiée par ailleurs (Nicot 1961); nous ne retiendrons ici qu'un *Penicillium* remarquable par sa couleur noire et ses spores épineuses de grande taille. Il a été isolé une seule fois, dans le sable ferrugineux, à 20 cm de profondeur.

CARACTERES CULTURAUX ET MORPHOLOGIQUES

Sur milieu de Czapek: Colonies à croissance limitée (2,5 à 3 cm en deux semaines à 24°C), rases et veloutées en surface, sur un feutrage membraneux compact, creusé de plis radiaires (aspect en roue caractéristique); de couleur noir fuligineux à olivacé, devenant noir mat et pulvérulent avec l'âge, bordées de blanc pur sur 1 à 2 mm; revers jaune sale à gris ocracé; odeur indistincte; aucun exsudat. Appareils conidiens

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portés par des conidiophores généralement courts sur les hyphes superficielles; pinceaux peu serrés; spores brunes volumineuses en chapelets divergents ou emmêlés avec l'âge, jamais associés en colonnes (Figure 1).

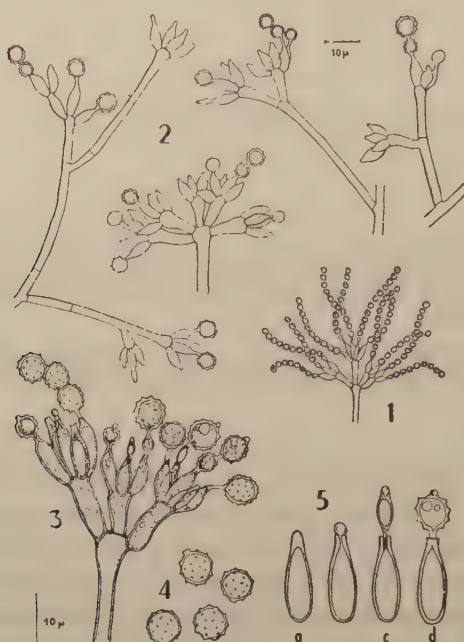


Figure 1

Penicillium megasporum. 1. Aspect général d'une chaînette de conidies (schématique); 2. Diverses dispositions de l'appareil sporifère ($\times 450$); 3. Détail d'un pinceau portant des spores à divers stades de leur développement; 4. Conidies mures (3 et 4: $\times 700$); 5. Représentation schématique des premiers stades de la sporogénèse (explication dans le texte).

Conidiophores peu distincts du mycélium végétatif; d'abord lisses, ils apparaissent tardivement rugueux par le dépôt d'exsudats lipidiques (colorables par le bleu BZL) qui diffusent à travers la paroi; les anastomoses sont fréquentes entre filaments mycéliens ou même conidiophores; les pinceaux conidiens se différencient soit à l'extrémité d'hyphes superficielles dressées, soit sur des branches latérales de longueur variable: 20 à 50 μ ou d'avantage. Appareil conidien de complexité variable, le plus souvent formé d'un seul verticille de 3 à 6 métules divergentes, lisses ou d'aspect rugueux, subhyalines, de (6)8–12(14) \times 2,5–4,5 μ , souvent élargies au sommet; phialides groupées en verticille de 4 à 7 au sommet de la métule, plus ou moins divergentes, en forme de bouteilles courtes et renflées de 7–10 \times 3–4 μ , à col bien marqué de 1 à 1,5 μ de diamètre.

Spores volumineuses, sphériques, de 5 à 6 μ de diamètre, à paroi épaisse, verruqueuse ou épineuse, brun noir (Figure 4). L'appareil conidien peut être réduit, surtout dans les colonies jeunes, en voie de croissance active, à un petit nombre de métules divergentes (2 ou 3) peu serrées, ou à de courts rameaux mycéliens simples ou ramifiés terminés par un verticille de phialides (Figure 2); sa disposition rappelle alors celle des *Penicillium* monoverticillés du type *ramigena*.

Forme ascosporee non connue.

Sur milieu a l'extrait de malt: Colonies à croissance également limitée, régulièrement veloutées ou légèrement floconneuses à la périphérie, non plissées, gris-noir à noir d'encre; zone de croissance blanche à beige sale, très étroite ou le plus souvent intramaticale; revers jaune sale ou grisâtre.

Appareils conidiens généralement moins compacts que sur Czapek. Conidiophores plus constamment rugueux.

MODE DE DEVELOPPEMENT DES SPORES

Nous avons suivi, dans des cultures jeunes, le développement progressif des chapelets de conidies et tenté de préciser les modalités de la sporogénèse. On peut fréquemment observer, sur un même pinceau sporifère, des éléments à différents stades de la sporogénèse (Figure 3); on constate que la cellule fertile ("stérigmate" des auteurs) se comporte comme une véritable phialide. A l'origine elle présente la forme d'une bouteille avec une double paroi: une membrane externe ou *vagina* mince, légèrement brunâtre, et une membrane interne ou *locula*, hyaline, plus épaisse au niveau du col (Figure 5a). Au premier stade du développement, la vagina se rompt au sommet et le col se creuse d'un canal d'où émerge un petit bourgeon sphérique, très réfringent; nous avons constaté que ce bourgeon se colore faiblement par les colorants spécifiques des lipides, bleu BZL et rouge Soudan III; il semble constitué par une mince couche cytoplasmique enveloppant un globule lipidique (Figure 5b). Au stade suivant, le bourgeon s'est allongé; une large vacuole ovoïde en occupe le centre, entourée par un cystoplasme très dense; le globule lipidique est repoussé au sommet du bourgeon, les parois du col de la phialide forment une collerette autour de sa base (Figure 5c). La jeune spore s'organise ensuite à partir de ce bourgeon; elle prend une forme sphérique, la vacuole se fragmente, une double paroi se dessine: l'exospore, en continuité avec le pédicelle du bourgeon, se pigmente et s'orne de verrues épineuses colorables par le rouge Congo (donc vraisemblablement de nature chitinoïde); l'endospore se forme de novo au contact du cytoplasme; le globule lipidique persiste quelque temps en position apicale, sous l'exospore, puis se résorbe peu à peu (Figure 5d).

Après la formation de cette première spore, et quand elle a déjà acquis ses caractères définitifs, le pédicelle s'allonge et se renfle en son milieu; une deuxième spore se différencie à partir de ce renflement suivant les mêmes modalités que la spore initiale.

(Figure 3, à droite). Une troisième spore se formera ensuite sous la deuxième et ainsi de suite; des segments de pédicelle demeurent le plus souvent sous l'aspect de connectifs entre les spores successives, tandis que les parois du col de la phialide forment une collerette rigide persistante à la base du chapelet de conidies.

Dans ses grandes lignes, la sporogénèse se déroule donc suivant un schéma que Raper et Thom (1949) considèrent comme exceptionnel chez les *Penicillium*, mais qu'ils signalent chez *P. digitatum* Sacc. et figurent chez *P. tardum* Thom. L'exsudat lipidique qui précède le bourgeonnement cytoplasmique et accompagne la première spore dans sa maturation nous paraît caractéristique du développement de cette espèce. Les colorants spécifiques des lipides (bleu BZL ou rouge Soudan III) font d'ailleurs apparaître une abondante production de ces substances dans tous les éléments du champignon. De fines gouttelettes lipidiques diffusent peu à peu à travers la paroi du mycélium, des conidiophores, et même des métules et des phialides, et lui donnent tardivement un aspect rugueux; elles semblent participer à l'élaboration du pigment brun qui colore intensément l'exospore et imprègne irrégulièrement la membrane externe des phialides.

POSITION SYSTEMATIQUE

Par l'aspect des colonies, par la forme et la disposition des divers éléments de l'appareil conidien, cette espèce s'apparente étroitement à *P. nigricans* dans le groupe des *divaricata*. Elle s'en distingue cependant par la couleur franchement noire des colonies, la complexité moins grande des pinceaux conidifères dont la disposition se rapproche parfois de celle des *monovorticillata-ramigena*, et par la taille beaucoup plus grande des conidies.

P. radulatum, récemment décrit par Smith (1957), est également une espèce du sol, très sombre, à pinceaux divariqués et spores épineuses. Mais d'après la description et les microphotographies de l'auteur, elle diffère de notre souche du Liban par un certain nombre de caractères culturels et surtout morphologiques: dimensions relatives des éléments du pinceau conidifère, moins trapu, aspect fortement rugueux des conidiophores, taille des spores. Nous ne pensons donc pas que, en dépit des affinités évidentes, notre moisissure puisse être confondue avec *P. radulatum*. Par contre, et malgré des différences sensibles dans les caractères culturels, il semble qu'on puisse l'assimiler au *P. megasporum* Orpurt et Fennell (1955), isolé du sol de prairies aux U.S.A. Les souches américaines se distinguent surtout de la nôtre par une croissance plus rapide et une sporulation plus limitée. Il est permis de penser que le comportement inégal du champignon en cultures pures ne fait que refléter la diversité des conditions de développement dans des habitats naturels aussi différentes qu'un sol de prairie et le sable nu d'un rivage maritime. Pigmentation accentuée, sporulation précoce et abondante sont en effet parmi les traits les plus caractéristiques et les plus constants des micromycètes des sols sableux secs et mobiles, tels les sables désertiques, et traduisent sans doute une adaptation à ce milieu parti-

culier (Nicot 1955). Dans les limites de l'espèce *P. megasporum*, notre souche libanaise aurait la valeur d'une race biologique caractéristique d'un habitat aride.

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PREDICTION OF POWDERY MILDEW OUTBREAKS ON CUCURBITS ON THE BASIS OF SEASONAL FACTORS AND HOST AGE

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ABSTRACT

Field records of powdery mildew outbreaks on cucurbits in Israel, collected mainly between 1941 and 1958, have been analysed to determine how far seasonal factors and host age can serve for the prediction of mildew appearance on these crops. The identity of the mildew fungus is open to doubt, though perithecia of *Sphaerotheca fuliginea* have occasionally been found.

The age at which all cucurbits showed first mildew symptoms was always highest in crops sown in winter or early spring, and declined consistently as sowing was delayed until early summer (May-June). The age at which spring sown crops are first attacked by the mildew is lower in years with high spring temperatures than in those with cool springs. Where cucurbit crops of the same type (marrows, cucumbers or melons) are sown successively side by side, the mildew always appears earlier on the older crop. This was confirmed by field experiments. In a field experiment designed to establish the length of powdery mildew incubation on melons sown in May in the coastal plain, this period was found not to exceed an average of 16-19.5 days.

For the purpose of mildew prediction on crops sown in January to March, a threshold of mildew appearance may be considered to exist in late March or early April. The mildew never appears before this threshold date, appears close to it in years with warm springs, but may appear much later (early May), in years with cool springs. No such threshold value for mildew appearance exists for summer and autumn sown crops, and these generally show first symptoms about 25-35 days after sowing. Only in August sown crops in the Jordan Valley is mildew appearance delayed beyond this age.

A prediction schedule for powdery mildew appearance in Israel has been drawn up, taking into account threshold dates, spring temperature, and host age.

INTRODUCTION

Research towards the prediction of plant disease outbreaks has so far largely concentrated on diseases caused by strongly parasitic fungi. In their review of the subject, Miller and O'Brien (1957) described mostly prediction schemes for downy mildew and the allied *Phytophthora* diseases, and for some rust and scab diseases. What all these diseases have in common is (a) their dependence on conditions of high humidity; (b) the sporadic availability of inoculum; (c) restriction to a single host species, or a small number of such species, belonging to the same botanical family.

In the studies relating to the prediction of the above diseases little attention has generally been paid to the disease proneness of the host at various stages of its growth. The exception is Grainger's (1957) work on *Phytophthora infestans* and the relative proneness of potatoes to this pathogen at successive growth stages.

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No prediction schedules for powdery mildew diseases have so far been published. These diseases are often indifferent to humidity conditions, have wide host ranges covering in some cases diverse botanical families, and are therefore apt to be associated with a more constant supply of inoculum than can be expected with downy mildews. Another characteristic of powdery mildews is what Yarwood (1957) has called their compatible association with the host, resulting in slow or infrequent killing of the latter.

Earlier studies of powdery mildew diseases in Israel (Palti 1953) indicated in a general way that these diseases are often absent from their herbaceous hosts in the early stages of growth, increasing in intensity as the host matures. In the present study an attempt has been made, by field observation and experiment, to assess proneness of cucurbits to powdery mildew under the seasonal conditions prevailing in various parts of Israel.

POWDERY MILDEW OF CUCURBITS IN ISRAEL

The powdery mildew disease affects all types of cucurbit crops grown in all parts of Israel. This includes districts of widely varying climatic character, such as (a) the coastal plain with high atmospheric humidity, heavy summer dew, moderately hot summers and about 400–600 mm winter rainfall; (b) the interior valleys, including the Jordan Valley, at elevations below sea-level, with extreme heat and drought in summer, moderate temperatures and 300–400 mm rainfall in winter; (c) the Huleh Valley, intermediate in summer temperatures and with slight dewfall, but approaching the coastal plain in winter temperatures and rainfall.

Although the disease is ubiquitous, perithecia have been found on affected cucurbits only in rare instances in the Jordan Valley: on cucumbers in January 1947 and on vegetable marrows in December 1946. The casual agent has been determined by Rayss (1947) as *Sphaerotheca fuliginea* (Schlechtendahl) Salmon. In all the other cases of powdery mildew recorded on cucurbits in Israel—and these add up to several hundred specific records and thousands of more casual field observations—only the *Oidium* stage of the disease has been found. We are, therefore, unable to decide whether the species of powdery mildew generally found on these crops belongs to *S. fuliginea* only, and prefer to designate the pathogen as *Oidium erysipoides* Fries.

MATERIAL AND METHODS

Field surveys of the appearance of powdery mildew on cucurbits in Israel were carried out from 1941 to 1946 and from 1953 to 1958. In each case note was taken of the number of days elapsed between the date the crop was sown and the date of the disease record, and this is referred to as the age of the crop. Disease intensity was assessed by the scales previously worked out (Palti and Minz 1951), where disease categories designated as healthy, trace, very light, light, moderate, and very

severe were assigned marks of 0, 0.1, 0.5, 1, 2, 4, and 8. respectively. A total of 424 detailed field records was made.

The meteorological records used are the monthly statements published by the Meteorological Service of the Israel Ministry of Transport and Communication, and its predecessor under the British Mandatory Government. We preferred relative humidity to dew point data, because in the study of powdery mildew interest attaches to low ranges of moisture which are adequately indicated by the relative humidity of the air.

The monthly mean temperatures for the coastal plain have been calculated by summing up and averaging monthly means recorded for 1947-1946 and 1953-1956 at 3 meteorological stations along the plain (Nathanya, Tel-Aviv, and Lydda Airport); for the interior valleys means of records taken the same years at 2 stations (Tiberias and Beisan or Heftsi-Bah) were used; and for the Huleh Valley we used the monthly means recorded for 1953-1956 at 2 stations (Dafna and Kfar Blum).

In order to express temperature levels between the dates of sowing and of milder appearance in a single value, "seasonal means" of temperature were calculated as follows: the mean was taken of the two subsequent months (in the case of crops sown in January-February) or of the month of sowing and the next month (in crops sown from March onwards).

INFLUENCE OF SEASONAL FACTORS ON POWDERY MILDEW APPEARANCE

(a) Relation of Sowing Season to Host Age at Disease Appearance

In order to determine at which age cucurbit crops sown in various seasons show first symptoms of powdery mildew, an analysis was made of all records in which disease intensity was recorded as 0.1, 0.5 or 1. These records are presented in Table I, side by side with mean monthly temperatures for the months elapsing between sowing and disease appearance (seasonal means).

The data in Table I permit the following conclusions:

- 1) On marrows the average age at powdery mildew appearance declined month by month, as sowing advanced from January to April, with still lower values for August-October sowings.
- 2) On melons, host age at incipient mildew attack declined sharply from March to April-May sowings, and was again lower for June sowings.
- 3) On cucumbers, a similar decline is noticeable in crops sown in May, as compared with those sown in March-April, but there was no further decline in June-August sowings.
- 4) The age at which cucurbits were first affected by powdery mildew declined progressively with a rise in the "seasonal mean temperature", until this reached a level of about 20°C, but not necessarily above that level.

TABLE I

Relation of sowing seasons and their mean temperatures to age of cucurbits at powdery mildew appearance

Crop	Month of sowing	Mean "seasonal" temperature (°C)	No. of records	Age of host (days)	
				Average	Range
1. COASTAL PLAIN					
Marrows	January	13.8	6	90	65-110
	February	15.2	9	80	64-93
	March	17.5	10	60	39-75
	August	25.7	8	42	28-57
	September	23.8	5	33	28-36
	October	20.4	7	42	32-61
Melons	March	17.5	10	65	49-82
	April	20.3	13	54	34-71
	May	22.1	16	48	28-68
	June	24.5	7	37	25-53
Cucumbers	February	15.2	6	74	48-89
	March	17.5	12	66	42-87
	April	20.3	16	54	32-73
	May	22.1	10	43	26-55
	June	24.5	11	44	18-53
	July	25.9	12	38	28-55
	August	25.7	14	37	27-56
	2. JORDAN VALLEY				
Cucumbers	August	30.0	5	43	36-50
	September	27.2	9	44	23-51
3. HULEH VALLEY					
Melons	July	27.2	8	42	30-53
Cucumbers	August	26.5	5	44	31-66

(b) Spring Temperatures and Host Age at Mildew Appearance

To ascertain how far temperatures prevailing in spring affect the age at which cucurbits are first affected by powdery mildew, records made in the central coastal plain in years with widely divergent spring temperatures are presented in Table II. The records are presented in pairs, each pair referring to sowings made in the same month.

The data indicate that on both marrows and cucumbers the age at which powdery mildew first appeared was invariably lower in years with higher spring temperatures. This applied to crops sown as early as January and as late as May.

(c) Incubation Period of Powdery Mildew on Summer Sown Melons

The following experiment was carried out in the Coastal Plain in order to obtain at least a preliminary idea of the length of powdery mildew incubation on melons sown in May, 1958.

TABLE II

Effect of spring temperatures on age of cucurbits at powdery mildew appearance (Coastal Plain)

Crop	Date of		Disease intensity	Age of host (days)	Meteorological data		
	Sowing	1st mildew			Month	Mean temperature (°C) monthly	"seasonal"
Marrows	25.1.56	10.5.56	0.5	105	February	15.6	
"	1.2.56	14.5.56	0	104	March	14.8	16.0
Cucumbers	15.2.56	10.5.56	0	85	April	17.8	
Marrows	25.1.55	17.4.55	0.5	82	February	16.6	
Cucumbers	14.2.55	28.4.55	1	74	March	17.2	18.0
					April	20.2	
Marrows	15.3.43	10.5.43	0	53	March	13.2	14.6
Cucumbers	10.3.43	24.5.43	0	74	April	15.9	
Marrows	15.3.46	7.5.46	0.1	52	March	14.6	16.0
Cucumbers	25.3.46	7.5.46	0.1	42	April	17.4	
Marrows	8.4.53	14.6.53	0	66	April	16.8	
"	5.5.53	30.6.53	0.5	55			18.6
Cucumbers	15.4.53	27.6.53	0.5	73	May	20.4	
"	5.5.53	30.6.53	0.1	55			
Marrows	22.4.42	7.6.42	0.1	45	April	17.0	
Marrows	10.5.42	11.6.42	0.1	31			20.0
"	20.5.42	20.6.42	0.5	30			
Cucumbers	5.5.42	11.6.42	0.1	36	May	23.0	
"	6.5.42	17.6.42	0.1	41			

Melon vines with 8–10 leaves were chosen 38 days after sowing, when not more than the two lowest leaves showed a few mildew specks. On these vines the top leaf, which just began to unfold, was labelled. This leaf was then examined at intervals of 3–4 days, in order to record the first appearance of powdery mildew symptoms. Of the 20 leaves first labelled, 4 broke off; and observations were completed on 16 leaves.

The period elapsed between the date on which the leaf unfolded and was labelled and the date on which the leaf first showed mildew symptoms may be considered as the maximum incubation period under the conditions of this plot. The actual incubation period may be shorter because (a) mildew spores did not necessarily germinate on the leaves on the day they unfolded, though the presence of spots on the older leaves shows that inoculum was available; and (b) records being taken at 3–4 days' intervals, the first symptom might have appeared on the days following the last examination on which the leaf was still found healthy, and the incubation period would then be 2–3 days shorter than indicated.

Our examinations showed that out of 16 leaves, 4 developed mildew symptoms after maximum incubation periods of 11–14 days, 6 after 14–17 days, 5 after 17–21 days, and 2 after 21–24 days. The average period was 16–19.5 days.

We refer to Table I, and note that the age at which melons sown in May in the coastal plain were found to show incipient signs of powdery mildew averaged 48 days (in 16 records), the minimum age being 28 days. The results of the above expe-

riment show that, as far as the incubation period is concerned, these symptoms could well appear much sooner.

POWDERY MILDEW APPEARANCE ON CUCURBITS SOWN SUCCESSIVELY SIDE BY SIDE

The data presented in the preceding sections show that the age at which powdery mildew appears on cucurbits depends on the season of sowing, and perhaps more particularly on the temperatures prevailing at that season. It may, however, be argued that absence or scarcity of inoculum could at least in part explain the delay of disease appearance on crops sown early in spring. In fact, in the absence of perithecia, there may be some doubt how the powdery mildew passes the winter, and how much inoculum is present in early spring.

In order to obtain valid data on the role played by the age of the host, we have assembled survey records and carried out some field experiments to determine disease appearance in crops sown successively side by side. In all these instances, appearance of the disease on the older crop demonstrates the availability of inoculum, and non-appearance of the disease on the younger crop grown under identical conditions can be associated with the age factor, if a suitable time is allowed for the incubation period.

(a) *Survey Records*

Pertinent records were collected on marrows, cucumbers and melons in 1942, 1943, 1953, 1955–1958, in the Coastal Plain, interior valleys and the Huleh Valley on crops sown at all seasons. Where the older crop was sown in January–March, the younger crop was sown 25–30 days later; in later sowings of fast growing summer cucurbits the sowing interval was only 15–20 days.

These records may be summarized as follows:

1) In 6 pairs of crops sown in January–March, the older crop aged 80–100 days showed disease intensities of 1.5–2, while the adjoining 50–70 days old crops were quite free from disease. In 3 further pairs sown at that season the older crop showed disease intensities of 2–4, the younger crop of 0.1–0.5.

2) In 7 pairs of crops sown between April and August, the plants aged 50–70 days were mildewed with an intensity of 2, those 15–20 days younger only showed disease intensity 0.1–0.5. At the same season, in 4 further pairs the older plants were affected with an intensity of 1, while the younger plants were free from disease; and in 2 pairs disease intensities in the older and younger plants were recorded as 4 and 1, respectively.

(b) *Field Experiments*

Two experiments were carried out to trace the phases of powdery mildew development on cucurbits sown successively in adjoining plots under identical cultural and soil conditions.

1) *Marrows* were sown in the central Coastal Plain on sandy soil. The results of plant by plant examinations are tabulated below, with the figures in brackets denoting disease intensity. (Table III)

TABLE III
Powdery mildew development on marrows sown on adjacent plots one month apart

Date of examination	Plot sown on	
	14.1.57	12.2.57
24.4.57	No powdery mildew	No powdery mildew
4.5.57	5 out of 32 plants affected on 1-2 leaves, 1 speck of mildew per leaf (0.5) <i>Note:</i> Very little difference in size and development of plants on the 2 plots, plants on both bearing fruit.	No mildew on 70 plants
11.5.57	Most plants slightly mildewed (1)	7 out of 70 plants affected on 1-2 leave (0.5). Plant no. 7 affected on all old leaves.
25.5.57	All older leaves partly covered with mildew; many specks on younger leaves (2)	Mildew development only slightly less than on older crop
11.6.57	Almost complete mildew coverage on both crops (4)	

2) *Melons* were sown in the Jordan Valley, near the shores of the Sea of Galilee, on medium soil, on 10.2.57 and 5.3.57, respectively. No mildew was found in any of 5 weekly examinations up to and including 9.5.57. On 24.5.57, the fruit on the older plot was picked for the first time, while that on the younger plot was also almost ripe. There was no apparent difference in the foliage development of the two plots. On this date 20 melon vines were extracted at random from the maze of growth on each plot, and each of their leaves was graded as to the incidence of powdery mildew. The results were as follows:

TABLE IV
Incidence of powdery mildew on melons sown on adjacent plots 23 days apart
(The figures represent number of leaves examined on 20 vines)

Mildew grading	Plot sown on	
	10.2.57	5.3.57
Healthy	164	204
With 1-2 specks of mildew	40	6
With more than 2 specks of mildew	4	0

The above survey records and experimental observations indicate that the incidence of powdery mildew on cucurbits is lower in the younger crops. The difference between crops sown successively side by side may differ in extent under various conditions of climate and inoculum, but it was constantly present. In some cases,

e.g. the marrows sown in the first experiment, disease intensity in the younger crop may eventually catch up with that in the older crop.

The above data support the conclusion that, in the earlier phases of their development cucurbit plants are less prone to powdery mildew attack than in the more advanced phases of their growth. This conclusion applies to marrows, cucumbers, and melons, as sown in the temperate and hot districts of Israel covered by this study, at all growing seasons.

PREDICTION OF POWDERY MILDEW APPEARANCE ON CUCURBITS

The data so far presented indicate in a general way that host age and spring temperature influence powdery mildew appearance on cucurbits. However, information of greater accuracy is needed for responsible prediction of such appearance in various parts of the country.

In the following we shall attempt to analyse our records to define threshold dates *before* which the mildew is not known to appear on spring crops and to show how far early mildew appearance can be linked with temperature data. We shall then combine all the conclusions arrived at to draw up a prediction schedule for mildew appearance.

The Threshold of Mildew Appearance in Spring

The cucurbit crop sown earliest in spring is the crop of marrows sown in January-February in the coastal plain. As proneness to powdery mildew attack appears to increase with age, this early marrow crop is generally affected by the disease before any other crop of cucurbits. Records collected on early marrows were, therefore, assembled to determine the earliest dates of mildew appearance in spring. This date was found to vary between late March and the second half of May. In an attempt to find a climatic factor associated with this wide variation in dates, the temperature prevailing in March seemed to be of possible significance. Table V presents earliest records of mildew for 19 years, with relevant March temperatures.

These data lend themselves to the following interpretation:

a) On marrows sown in January-February, powdery mildew did not appear before the second half of March, and this can be considered the threshold date of spring appearance of the mildew on cucurbits.

b) In 8 out of 10 years, the mildew did not appear until April, and in 7 years only in or after mid-April.

c) In general, mean March temperatures above 16°C were associated with early mildew appearance (24 March — 20 April), while means below 14.5°C were associated with delayed mildew appearance (May). Where temperature means were between 16 and 14.5°C, the mildew appeared sometimes early (1942) and sometimes later (1957). This was to be expected where a climatic value as crude as a *monthly* mean is used as a clue to the date of appearance of a disease which might be influenced by temperature spells of much shorter duration. However, it seems justified

to conclude with due caution that powdery mildew appearance in spring, on marrows sown in January-February, is likely to be early where March mean temperatures are above 16°C , and will be markedly delayed where this mean falls below 14.5°C .

TABLE V

Earliest records of powdery mildew on spring marrows and relevant mean temperatures for March (Coastal Plain)

Locality	Date of		Disease intensity	Age of host (days)	Monthly mean temperature for March
	Sowing	1st mildew record			
Ramat Hasharon	11.1.60	24.3.60	0.5	63	16.0
Ramat Hasharon	20.1.58	25.3.58	0.1	65	16.4
Mikve Israel	15.2.42	3.4.42	0.1	48	15.1
Nordia	25.1.55	17.4.55	0.5	82	17.2
Gan Yavne	2.54	20.4.54	0.5	ca 65	16.3
Hadassim	14.1.57	4.5.57	0.1	110	15.3
Kefar Yona	25.1.56	10.5.56	0.5	105	14.2
Natanya	2.53	18.5.53	0.5	ca 93	13.9
Sha'ar Ha'amakim	25.2.46	20.5.46	0.1	85	12.9
Mishmarot	2.43	24.5.43	0.5	ca 99	13.4

Host Age and Mildew Appearance on Summer and Autumn Sown Crops

An analysis of 196 records of incipient powdery mildew attacks (disease categories 0.1-0.5) on summer sown cucurbits has failed to show any connection between onset of mildew on these crops and earliness of its appearance on the spring crop or temperature levels in spring or summer. This would appear to be due to (a) summer temperatures (between April-May and October) constantly suitable for powdery mildew development, and (b) ample supply of mildew inoculum from the spring crops of cucurbits and possibly from other hosts.

Reverting to Table I, we note that the lowest age at which marrows, melons, and cucumbers sown between April and October in the coastal plain are first attacked by powdery mildew is fairly constant and ranges from 25 to 34 days. Only in a single instance (June 1942) has a cucumber crop been found affected after 18 days. Cucurbits sown in March were always affected at minimum ages intermediate between those noted for crops sown in February and in April.

The age at which mildew first appears on melons sown in July and on cucumbers sown in August in the Huleh Valley also falls within the above range of 25-34 days.

As regards the onset of powdery mildew on cucumbers sown in August-September in the Jordan Valley, we present relevant data in Table VI. These data, culled from 42 records, show that the mildew has never been found on these crops before the end of September, and usually appears only in October. This holds true even for crops sown in mid-August, which are then 5-6 weeks old. We believe this delay of mildew appearance in the crop sown in August to be due to the extremely high temperatures prevailing in the Jordan Valley up to mid-September. For the purpose

of prediction, a threshold for mildew appearance on autumn sown cucumbers in this valley may be considered to exist at the end of September.

TABLE VI

Earliest records of powdery mildew on cucumbers sown in the Jordan Valley in August-September

Locality	Date of		Disease intensity	Age of host (days)
	Sowing	1st mildew record		
Nir David	29.8.42	7.10.42	0.1	38
Tel Jossef	22.8.42	6.10.42	0.1	44
Kinneret	25.8.42	16.10.42	0	40
Kinneret	25.8.42	16.10.42	1	50
Nir David	25.8.41	14.10.41	0	49
Tirat Tsevi	15.8.46	2.10.46	0	47
Sdeh Nahum	5.9.43	28.9.43	0.5	23
Kinneret	5.9.42	6.10.42	0	31
Kinneret	5.9.42	6.10.42	0.5	40
Kinneret	12.9.42	16.10.42	0	34
Degania	5.9.41	15.10.41	1	40
Havat Shemuel	5.9.55	17.10.55	0.5	42

A Prediction Schedule for Powdery Mildew Appearance on Cucurbits in Israel

This tentative schedule for predicting powdery mildew appearance on cucurbit crops at various seasons is based on our conclusions concerning the connection between disease appearance and host age. In order to leave an adequate safety margin, predictions are based on a mean of the 3 lowest age records of mildew appearance made over the years for each month's sowing, only the very earliest record for any one year being taken into account.

In addition to host age, consideration has been given (a) for cucurbits sown in January-February in the coastal plain, to the effects of March temperature, and (b) for cucumbers sown in August-September in the Jordan Valley to the threshold of mildew appearance in late September.

In the prediction schedule presented here for cucurbit mildews, host age has been stated as the number of days elapsing between sowing and first disease appearance on the crop. (Table VII). For purposes of generalisation, these age figures have to be brought into relation with the length of the entire vegetative period of the host at various seasons. Thus the age of the host at disease outbreak has to be stated as percentage of its entire life. We shall refer to this percentage as the "relative age" of the host. The relative age at which mildew may be expected to appear on cucurbits in Israel is shown in Table VIII.

From the practical point of view it has to be noted that powdery mildew appearance on cucurbits that have completed 80 percent of their vegetative period is unlikely to cause economic losses, even though the disease progresses rapidly on the ageing crop. Only mildew appearance at earlier stages of host growth will generally justify control measures.

DISCUSSION

The requisites for plant disease outbreak are the presence of viable inoculum and of hosts in a state of disease proneness, together with climatic conditions facilitating infection and disease development. We shall now briefly discuss these factors in relation to the prediction of powdery mildew on cucurbits.

Availability of Inoculum

If we assume that all powdery mildew appearing on cucurbits in Israel belongs to the species *Sphaerotheca fuliginea*, inoculum is readily found from April-May until January on successive sowing of cucurbits in the coastal plain and the interior valleys. When conditions permit sowing of vegetable marrows in November, the powdery mildew is regularly apparent in February; in a cucumber plot sown experimentally in November 1957 in the Coastal Plain, the mildew was likewise recorded in February 1958. Moreover, when cucurbits were sown in January-February in glasshouses newly erected near Tel-Aviv, the mildew appeared within 14-18 days of seedling emergence.

On hosts other than cucurbits, Rayss (1959) has found perithecia of *S. fuliginea* in February on *Erigeron crispus*. This weed is common in the coastal plain and is often severely mildewed.

Reviewing the above facts, it appears reasonable to assume that inoculum of *S. fuliginea* is available in Israel at all seasons of the year, although there may be considerable fluctuations in the quantities available.

Humidity and Temperature Relationships

Earlier studies carried out in Israel have shown that the powdery mildew prevalent there on cucumbers is remarkably independent of humidity factors: Duvdevani, Reichert and Palti (1946) demonstrated that presence or absence of dew makes little difference to the development of this mildew; and Palti (1953) concluded from an analysis of survey data that development of the cucumber mildew was unconnected with the level of relative atmospheric humidity in various parts of the country.

The temperature relationships of powdery mildews have been authoritatively reviewed by Yarwood *et al.* (1954), who indicated the high temperature optimum of 28°C for *Sphaerotheca fuliginea*. This indication certainly agrees with our conclusion that our powdery mildew of cucurbits, which has in some cases been identified as *S. fuliginea*, is favoured by high spring temperatures. The preference of this mildew for high temperatures is further shown by its early and profuse development on summer sown cucurbits, in months with mean temperatures approximating 22-27°C.

However, there is reason to believe that the extreme temperature prevailing in the Jordan Valley in mid-summer (August means of about 30°C) tends to delay the appearance of powdery mildew on cucurbits. Yarwood (1957) has noted that the

TABLE VII
Prediction schedule for powdery mildew outbreaks on cucurbits in Israel

Crop	Month of sowing	Mean March temperature	Expected time of mildew outbreak	
			Month	Age of crop
COASTAL PLAIN				
Marrows	January	Above 16°C Below 14.5°C	Late March – mid April Late April–mid-May	10–12 weeks 14–16 weeks*
Marrows	February	Above 16°C	Early to mid-April	8–10 weeks
Cucumbers		Below 14.5°C	Early to mid-May	12–14 weeks
Melons	February	Above 16°C Below 14°C	Early to mid-May Late May	11–13 weeks 13–15 weeks*
Marrows Cucumbers	March			6–8 weeks
Melons	March			8–9 weeks
Marrows Cucumbers Melons	April			5–6 weeks
Marrows		May–October	}	25–35 days**
Cucumbers		May–August		
Melons	May–July			
INTERIOR VALLEYS (including Jordan Valley)				
Cucumbers	August September		Not before late September	35–50 days 25–40 days
HULEH VALLEY				
Melons, Cucumbers	May August			30–40 days

* Mildew appearance at this late stage is no longer of economic importance.

** Exceptional cases of mildew appearance at an earlier age may occur in mid-summer sowings.

TABLE VIII
Relative age of cucurbits at powdery mildew appearance under diverse regional and seasonal conditions

Relative host age at mildew appearance	Crop	Months of sowing	Region	Mean March temperature
up to 30–40%	Cucumbers Marrows Melons	May–October May–August September	Coastal Plain Huleh Valley Interior valleys	
up to 50–60%	Cucumbers Marrows Melons	March–April August March–April April	Coastal Plain, Interior valleys Coastal Plain Coastal Plain Huleh Valley	
up to 70–80%	Cucumbers, Marrows Melons Marrows	February March January	Coastal Plain Coastal Plain Coastal Plain	Above 16°C
above 80%	Cucumbers, Marrows Marrows Melons	February January February	Coastal Plain Coastal Plain Coastal Plain	Below 14.5°C

tolerance of powdery mildews to heat is usually lower than that of their hosts. He also mentions that the greater prevalence of certain powdery mildews in the coastal area of California, as compared to the interior valleys, may well be due to the lower summer temperatures of the coastal area. This agrees well with our observations on the relative development of cucumber mildew sown in summer in the hot Jordan Valley and the cooler coastal plain of Israel.

Host Age

Our interest in the connection between the stage of growth, or age, reached by the host and its proneness to attack by powdery mildew at each season, is an eminently practical one: the desire to help and define the likelihood of mildew attack by a criterion available to every farmer who knows on which date he has sown his crop.

We are aware that the increased likelihood of mildew outbreaks at a given stage of host development may, *inter alia*, be due to the following factors:

1) Changes in the crop's microclimate, due to increasing density of foliage. Blumer (1933) quotes several examples of reduced air circulation within the crop being favourable to powdery mildew development.

2) Greater chances for the older crop to encounter, in the extended course of its growth, climatic conditions favourable to infection, incubation, and sporulation.

3) Increasing loads of inoculum of an ageing crop, as sporulation on the parts first affected increases progressively.

4) Heightened chances for older crops to become more susceptible to powdery mildews through injuries by pests, natural agencies (e.g. hail, sandstorms), leaves rubbing against each other, or by picking and other operations. This has also been referred to by Blumer (1933) and Berwith (1936).

5) Inherent changes in susceptibility as the host passes through various stages of growth. In relation to powdery mildew of cucurbits this has been studied by Uozumi and Yoshi (1952): they found leaves up to 3 days old most resistant to the mildew, and those 16–23 days old most susceptible. Reviewing the Erysiphaceae as a whole, Blumer (1933) states: "Sicher ist aber, dass die Anfälligkeit in hohem Grade durch das Alter der Nährpflanze oder ihrer Organe bedingt ist. Im allgemeinen kann man den echten Mehltau, im Gegensatz zum falschen, als eine Alterskrankheit bezeichnen".

However, we do not consider it essential for our purpose to analyse the causes why the age of the host may affect its susceptibility to powdery mildews, how the above factors interact or, indeed, whether there is a causal relationship between age and disease development. We only wish to determine whether, under certain seasonal conditions, the likelihood of mildew outbreak increases as the plant passes through various age phases, i.e. whether its age may be linked with the degree of its proneness to disease.

Our studies of the powdery mildew of cucurbits has shown that, under the conditions prevailing in Israel, the relation between mildew occurrence and host age at a given season was definite enough to furnish an important element in the prediction of this disease.

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GRISEOFULVIN—ITS ACTION. ON THE SAPROPHYTIC AND PSEUDO-PARASITIC LIFE-PHASE OF DERMATOPHYTES

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ABSTRACT

Higher concentrations of Griseofulvin were necessary to completely inhibit the pseudo-parasitic than the saprophytic phase of various dermatophytes.

Characteristic microscopic morphologic changes were produced by sub-inhibitory doses of the antibiotic.

An attempt was made to imitate the conditions during the treatment of the natural disease by allowing the pseudoparasitic phase of the fungus to mature before adding the antibiotic.

The purely fungistatic action of griseofulvin was demonstrated.

Griseofulvin (GF) causes peculiar morphological changes in the organisms upon which it acts. Numerous reports have described its effect on dermatophytes on both solid and liquid media (Roth *et al.* 1959; Schwartz and Loutzenhiser 1960; Proc. of International Symposium 1960). Changes in fungal elements in the hairs of children undergoing GF treatment for tinea capitis have been reported, as well as changes in the hairs of experimentally infected animals (Mullins *et al.* 1959; Degos and Rivalier 1960; Frey and Geleick 1959; Gentles 1959).

The therapeutic results obtained with GF in various types of fungous infections have generally been good, but failure to cure has occurred (Esteves and Neves 1959; Berry *et al.* 1960; our unpublished observations). In some cases the fungous strains may have been either naturally resistant to GF or may have acquired resistance during treatment. Viable fungous elements may have remained dormant in the keratinous layers of hair follicles and resumed activity when the dose of GF was reduced or the treatment stopped (Barlow *et al.* 1959; Rosenthal *et al.* 1959).

The aim of the experiments described in this paper was to compare the sensitivity of the saprophytic and the pseudoparasitic phases of various dermatophytes to GF. An attempt was made to imitate the relationship between GF and the fungus in the treatment of the natural disease, by allowing the pseudoparasitic life phase of the fungus to develop to maturity before adding GF. The morphologic changes caused by the drug were studied both macroscopically and microscopically.

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MATERIALS AND METHODS

The dermatophytes were fresh isolates from human cases of various types of tinea. Four strains of *T. mentagrophytes*, four of *T. rubrum*, two of *T. tonsurans*, four of *T. violaceum*, five of *T. schoenleini* and three of *E. floccosum* were used. The organisms were regularly transferred on 2% dextrose agar slants. In most cases the inoculum was prepared as previously reported (Raubitschek 1955), 0.2 ml being used for each flask. In the case of *T. violaceum*, however a different technique was used. Slants were flooded with 8 ml sterile distilled water and the colonies were scraped off the surface and broken up by a stiff wire. After shaking thoroughly the larger particles were allowed to settle, and 1 ml of the supernatant was used as inoculum for each flask. The same stock suspensions were also used as inocula in setting up stationary cultures. A wire with its terminal 0.5 cm bent at an angle of 90° was immersed once into the stock suspension and three streaks were made on the surface of the agar.

The GF* was dissolved in acetone (10mg/10ml), and if necessary this stock solution was further diluted with sterile distilled water. In the stationary experiments the required amounts of GF were pipetted into petri dishes and thoroughly mixed with 10 ml of molten 2% dextrose agar. Similar plates without GF served as controls. The concentrations of GF used ranged from 0.5μ to 100μ/ml agar. After hardening, the surface of the agar was divided into several sectors, on each of which one of the organisms was streaked. In the shake experiments various amounts of the GF stock solution were aseptically added to 100 ml of sterile medium (0.5% dextrose; 0.3% ammonium sulfate; 0.2% K_2HPO_4 ; $MgSO_4 \cdot 7H_2O$ and $CaCl_2$ 0.005% each, in double-distilled water) in 250 ml erlenmeyer flasks. The concentrations of GF ranged from 0.2μ to 200μ/ml medium. Flasks without antibiotic served as controls. After adding the inoculum, the flasks were shaken at 26°C on a Ross-Kershaw continuous shaking machine. Each experiment was set up in duplicate, and repeated several times. From those flasks in which growth appeared pellets or flakes were periodically removed with a sterile needle, teased out on slides, fixed in methanol, and stained by the PAS technique. The completely inhibiting concentrations were determined after four to six days depending on the organism. This was the time necessary for development of mature growth in the controls. On further incubation no change occurred. In other experiments the inoculated flasks were shaken for 7 or 14 days, by which time a luxurious growth was present. GF was then added aseptically to give concentrations of 50 and 100μ/ml respectively, preliminary experiments having shown that lower concentrations did not give clear-cut results. One flask without GF served as a control in each series. The flasks were replaced on the shaker and the incubation continued. Particles of growth were periodically removed and examined microscopically.

* Pure crystalline griseofulvin was kindly supplied by Mr. J. C. H. Hanson, M.P.S, of Glaxo Laboratories Ltd., Greenford, Middlesex, England.

RESULTS AND COMMENT

From table I it can be seen that complete inhibition of all organisms can be accomplished in stationary culture (saprophytic phase) with smaller amounts of GF than are needed with continuous shaking (pseudoparasitic phase). In the latter case the microscopic morphology of the fungus resembles that seen in disease, lacking the fructification structures of the saprophytic phase (Evron-Maoz and Raubitschek 1960). The greater resistance to the antibiotic shown by *T. mentagrophytes*, and especially by the pseudoparasitic phase of *T. schoenleini*, is striking. Subinhibitory amounts of GF, even as small as 0.2 to 0.5 $\mu\text{g/ml}$, caused marked morphological disfigurements in the pseudoparasitic phase of *T. mentagrophytes*, *T. tonsurans*, *T. rubrum* and *E. floccosum*. These consisted of the appearance of large numbers of irregularly shaped and sized chlamydospores, and various deformations of the hyphae, with terminal swellings and curling. Some hyphae showed ring-like formations, with occasional knob-like swellings on the periphery. Arthrospore formation decreased or was absent. Such changes could not be detected with certainty with *T. violaceum* and *T. schoenleini*, due to the natural polymorphism of the pseudoparasitic phase of these organisms (Evron-Maoz and Raubitschek 1960). The gross morphology was also affected, to a degree depending on the concentration of GF. The first sign was fuzziness and a decrease in the size of the pellets. With higher concentrations no pellets were formed, the growth appearing in the form of a few

TABLE I

Minimal inhibitory concentration of GF ($\mu\text{g/ml}$) on the saprophytic and pseudoparasitic life phase of some dermatophytes*

Organism	Saprophytic	Pseudoparasitic
<i>T. mentagrophytes</i>	50	70
<i>T. rubrum</i>	5	50
<i>T. tonsurans</i>	10	50
<i>T. schoenleini</i>	10	150
<i>T. violaceum</i>	10	50
<i>E. floccosum</i>	10	30

* Average from repeated experiments with several fungus strains. Results after 4 to 6 days incubation at 26°C. Duration of experiment 12 days.

TABLE II

Amount of GF (mcg/ml) necessary to cause disintegration of pellets of mature pseudoparasitic phase of dermatophytes*

Organism	Days of growth before addition of GF	
	7	14
<i>T. mentagrophytes</i>	100	100
<i>T. rubrum</i>	50	100
<i>T. tonsurans</i>	50	50
<i>T. schoenleini</i>	—	50
<i>T. violaceum</i>	50	50
<i>E. floccosum</i>	50	50

* Observation period after addition of antibiotic: 3 weeks. Temperature 26°C.

regular flakes. These diminished in number as completely inhibitory concentrations were reached. Table II shows the concentrations of GF necessary to cause changes in the already mature pseudoparasitic phase of the fungi. These changes were seen after further shaking for 4 to 10 days following the addition of GF. The same microscopic changes as described above were observed. Macroscopically there was a tendency for the pellets to disintegrate into loose strands and flakes of mycelium. With *T. rubrum* a larger amount of GF was necessary to disintegrate the 14-day old than the 7-day old pellets. In one experiment using *T. mentagrophytes* the visible growth completely disappeared about 15 days after the addition of 100 μ /ml GF to the mature fungus growth. However when a loop of the medium, which appeared completely devoid of fungus growth, was transferred to a dextrose agar slant, normal granular growth of *T. mentagrophytes* took place.

These findings indicate that although GF causes disturbance of growth and even cessation of reproduction, its effect is purely fungistatic. If the pseudoparasitic phase of dermatophytes is accepted as being similar to the parasitic one these findings might have some bearing on clinical failures with the use of this antibiotic.

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A PROPOS DE L'INFECTION DU MAIS PAR LE *SOROSPORIUM*
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ABSTRACT

Between the years 1954-1959, experiments were carried out with the aim to elucidate some aspects of corn infection with *Sorosporium holci sorghi*. (= *S. reilianum*).

The obtained data showed that the stage of infection of corn seedlings occurs during the first 16-24 days from the germination of the grain, the seedlings being susceptible to infection till they reached a height of 24-26 cm. The strongest attack was observed during the first stage of emergence when the seedlings had a height of only 2-3 mm. During the emergence stage, fungus invasion may occur on the whole length of the plant. The seedlings grown in the dark were susceptible to a stronger attack than those grown in light.

Up to the depth of 8 cm fungus invasion has a progressive development, while below this depth it remains more or less at the same level.

Divers auteurs (Christensen 1926; Kispatic et Lusin 1952-1954; Nemlienko 1940; Radulescu *et al.* 1957, 1958, 1959) ont montré l'importance de certains facteurs sur l'infection du maïs par le *Sorosporium holci sorghi* (= *S. reilianum*) tel que la température et l'humidité, la concentration en ions H (le pH) du sol, les engrais minéraux et organiques, le degré d'infection des semences et du sol par les spores, l'époque des semis, etc.

Par ailleurs, nous sommes moins renseignés sur la durée du stade de réceptivité du maïs, sur l'âge quand la plantule présente la plus grande sensibilité et sur l'influence exercée par divers autres facteurs sur l'infection, tel que les conditions de lumière pendant le développement des plantules, l'épaisseur de la zone infectieuse traversée par la plantule et la profondeur des semis.

Dans ce travail, nous présentons les résultats obtenus à la suite des expériences* effectuées en 1954-1959 et se rapportant à ces derniers aspects sur l'infection du maïs par le *Sorosporium*.

MATERIEL ET METHODES

Dans la plupart des cas nous avons utilisé le cultivar de maïs Portocaliu qui s'est révélé très sensible au *Sorosporium* dans les expériences antérieures (Radulesco *et al.* 1957).

* Les expériences ont été effectuées avec l'aide de E. Perseca et I. Popesco.

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Les expériences ont été effectuées tant dans le laboratoire, que dans la serre et le champ d'expérience. Dans certains essais, les plantes ont été continuellement maintenues dans la serre. Dans d'autres expériences, elles ont été d'abord élevées dans le laboratoire et en suite repiquées dans le champ à une distance de 70×70 cm, avec la terre du vase, après une période préalable de quelques jours d'accommodation aux conditions externes. Dans la plupart des expériences le maïs a été semé directement dans le champ.

Pour l'infection on a utilisé un mélange de terre et de spores dans la proportion de 1 kg de terre pour 2 g de spores, à part certaines variantes où la proportion changée est mentionnée. La terre bien tamisée a été mélangée uniformément avec les spores; ensuite elle a été humectée et maintenue pendant quelques jours à la température de $18-24^{\circ}\text{C}$ avant son utilisation.

Pour établir les résultats de l'infection on a noté séparément les plantes ayant les épis et les panicules attaquées, celles ayant seulement les épis ou seulement les panicules attaquées et finalement un nombre des plantes ayant les feuilles attaquées.

Dans le champ, les expériences ont été comparées avec des parcelles témoins dont les semences n'ont pas été infectées. Les plantes de ces parcelles n'ont jamais été attaquées, aussi nous n'avons pas mentionné cette variante dans les tableaux des résultats.

RESULTATS

La Durée du Stade de Réceptivité du Maïs

Certains auteurs (Gassner et Tiemann 1954, ainsi que la documentation indiquée par ces auteurs) ont établi par des expériences, que les infections dûes au *Tilletia* dépendent, entr'autres, du stade de développement du germe de blé. Ainsi, quand le germe a 1-2 mm de longueur il est très sensible à l'infection, tandis qu'à un stade plus avancé, quand il a plus de 20 mm de longueur, l'infection ne se produit plus.

En ce qui concerne l'infection dûe au *Sorosporium* sur le maïs, les meilleurs résultats obtenus par Kispatic et Lusin (1954) ont eu lieu avec des plantules de 5 mm de longueur.

Par les expériences effectuées en 1955-1959, nous avons essayé d'établir la durée du stade de réceptivité du maïs et la phase du développement de la plantule qui présente la plus grande réceptivité à l'infection au *Sorosporium*.

L'expérience préliminaire faite en 1955 a été exécutée d'après la technique suivante. Parmi un grand nombre de semences de maïs germées, on a choisi des lots de 200 plantules d'une longueur de 0.2, 0.4, 0.6, 2, 3, 5 et 6 cm. Chaque lot a été planté à une profondeur de 7 cm, dans des vases contenant de la terre mélangée avec des spores. Parallèlement on a semé des semences non infectées. Les vases ont été ensuite humectés modérément et maintenus à la température de $26-28^{\circ}\text{C}$ dans une étuve. Après la levée du maïs, les vases ont été mis dehors jusqu'à ce que les plantes ont atteint 10-15 cm de hauteur; ensuite le maïs a été repiqué dans le champ.

TABLEAU I
*Importance de l'attaque en fonction de la longueur
 des plantules au moment de l'infection*

Longueur de la plantule (en cm)	% des plantes attaquées
0	94.6
0.2	98.3
0.4	78.7
0.6	76.2
2.0	73.9
3.5	71.5
6.0	53.0

D'après les résultats obtenus (v. le Tableau I) on constate que la plus forte infection se produit dans les premières phases de développement des plantes de maïs (0.2 cm). Le pourcentage des plantes attaquées est inversement proportionnel à l'état de développement de la plantule au moment de l'infection. Pourtant, ce chiffre est assez élevé, même, quand la plantule a 6 cm de longueur.

Cette constatation nous a déterminé de continuer les expériences afin d'établir la dimension maximale du maïs qui peut être encore infectée. Dans ces expériences, les semences de maïs ont été semées deux à deux par poquets directement dans le champ, à une profondeur de 8 cm. Le nombre des parcelles semées a varié entre 10 à 20; chacune ayant 100–150 plantes et chaque variante 2–3 répétitions.

Au moment de la levée des plantes de la première parcelle et de ces répétitions on a enlevé la terre située autour des plantes, jusqu'à leurs racines. Ensuite, après avoir mesurer la hauteur des plantes, on a mis de la terre mélangée avec des spores jusqu'au niveau initial du sol. De la même sorte on a infecté toutes les plantes des parcelles et de leurs répétitions, à des intervalles de 2 à 6 jours.

En 1958, l'infection des plantes a été faite au moment des semis.

Les résultats obtenus au cours de ces essais (v. le Tableau II) montrent que le maïs peut être infecté, par le *Sorosporium*, après la levée et jusqu'à ce que les plantes arrivent à une hauteur de 24–26 cm. En calculant l'âge des plantes, à partir de la germination des semences, on constate que la durée de réceptivité de la plante à l'infection au *Sorosporium* oscille entre 16 à 24 jours, suivant l'époque des semis. En 1959, quand les semis ont été effectués tardivement, les plantes se sont développées plus vite à cause de la température plus élevée et sont arrivées plus rapidement à la hauteur maxima, quand elles pouvaient encore être infectées.

Les résultats de l'année 1958 confirment ceux obtenus en 1955, c'est-à-dire, que l'infection la plus forte se réalise dans les premières phases de développement de la plantule.

TABLEAU II
Infection du maïs par le Sorosporium, en fonction de l'âge et la hauteur des plantes

Semé le 18.V.1957			Semé le 28.V.1958			Semé le 25.VI.1959		
Hauteur moyenne des plantes attaquées (en cm)	Age des plantes (en jours)	% des plantes attaquées	Hauteur moyenne des plantes attaquées (en cm)	Age des plantes (en jours)	% des plantes attaquées	Hauteur moyenne des plantes attaquées (en cm)	Age des plantes (en jours)	% des plantes attaquées
8	9	17.9	—	0	42.6	5	6	14.6
13	13	4.1	0.3	1	43.3	12	8	9.1
22	18	1.8	0.8	3	40.2	17	10	12.9
24	24	0.7	2	5	26.5	22	12	7.7
47	28	0	6	8	18.9	24	14	2.7
59	35	0	10	11	3.4	26	16	2.7
89	40	0	16	18	2.4	34	18	0
123	46	0	25	23	2.4	41	20	0
156	51	0	41	28	0	53	22	0
			59	32	0	65	24	0
			74	36	0	77	26	0

La Receptivité de Diverses Parties de la Plantule

Dans la terre exempte de spores, mise dans des vases, nous avons semé du maïs à une profondeur de 8 cm. Dans chaque variante et à la distance de 1, 2, 3, 4, 5, 6 et 7 cm des semences, nous avons mis entre deux feuillets de papier, une couche d'une épaisseur de 1 cm de terre mélangée avec des spores. Ces vases ont été maintenus continuellement dans la serre, à une température variant entre 20-24°C.

Les résultats préliminaires indiqués dans le Tableau III montrent que les spores se trouvant dans le sol peuvent infecter toute la longueur des plantules de maïs, quand celles-ci traversent la couche infectieuse située au dessus des semences. Toutefois, l'infection est plus réduite dans la partie supérieure des plantules.

TABLEAU III
Receptivité de diverses parties de la plantule de maïs

Distance entre les semences et la couche infectieuse (en cm)	Nombre de plantes		% des plantes attaquées	Plantes avec feuilles attaquées	
	Total	Attaquées		Nombre	%
0	60	33	55.0	8	24.2
1	68	42	61.8	12	28.5
2	71	52	73.2	21	40.3
3	52	23	44.3	10	43.4
4	69	24	34.8	13	54.1
5	68	21	30.8	17	80.9
6	76	20	26.3	14	70.0
7	63	12	19.0	11	91.7

Dans cette expérience il y a une forte attaque sur les feuilles. Il est intéressant de souligner même le fait, que le pourcentage des plantes ayant les feuilles attaquées est d'autant plus élevé que la couche de terre infectieuse est plus éloignée des semences. Dans le même sens, l'intensité de l'attaque sur les feuilles a augmenté.

L'Influence des Conditions de Lumière pendant le Développement des Plantules de Maïs sur l'Infection dûe au Sorosporium

Rabien (1927), Gassner et Tiemann (1954) ont établi par des expériences que les plantules de blé développées à l'obscurité sont plus sensibles à l'infection du *Tilletia*, que celles développées à la lumière. D'après ces auteurs, le mycélium perfore les tissus de la plantule développée à l'obscurité, avec une plus grande facilité.

Nous basant sur l'analogie qui existe entre l'infection du blé par le *Tilletia*, et celle du maïs par le *Sorosporium*, nous avons effectué en 1958 une expérience nous permettant d'établir dans quelle mesure les conditions de lumière influencent la sensibilité du maïs à l'infection du *Sorosporium*.

Dans ce but, le 16 mai, nous avons mis à germer un grand nombre de semences de maïs. La moitié du nombre des germinateurs a été maintenue à l'obscurité, tandis que l'autre moitié a été mise à la lumière (à la température de 22°C). Une moitié du nombre des plantules a été repiquée dans des vases et l'autre moitié, directement dans le champ d'expérience. Le repiquage dans les vases a été fait en quatre étapes, c'est-à-dire, quand le quart du nombre des plantules avait 5, 10, 15 et 20 mm de long. Au repiquage, les plantules ont été enterrées dans un mélange de terre et de spores jusqu'à leur sommet et ensuite dans la terre exempte de spores, jusqu'à une hauteur totale de 7 cm, à partir de la semence. Les vases ont été maintenus dans le laboratoire à une température de 22-25°C jusqu'à la levée du maïs. Ensuite, après 2 semaines, les plantes ont été repiquées dans le champ. Le repiquage des plantes directement dans le champ a été effectué dans des trous et dans les mêmes conditions.

D'après les résultats obtenus (v. le Tableau IV) on constate que les plantes qui proviennent des plantules maintenues à l'obscurité présentent une infection plus accentuée.

En ce qui concerne l'importance de l'attaque, les différences sont plus grandes dans le cas des plantules repiquées directement dans le champ.

La plus grande sensibilité des plantes développées à l'obscurité ne peut pas être expliquée par l'influence que pourraient avoir les conditions de lumière sur la germination des spores, influence qui a été exclue par la mise en contact des spores avec la plante, seulement au moment du repiquage des plantules. Par ailleurs, dans une autre expérience, faite en 6 répétitions et un très grand nombre de spores, on a obtenu des différences insignifiantes entre le pourcentage des spores germées à la lumière et celles germées à l'obscurité. Dans cette expérience, le pourcentage des spores germées a été le suivant:

	à la lumière	à l'obscurité
après 4 jours	51.9	53.4
après 6 jours	60.8	61.6
après 10 jours	78.6	78.9

Nous considérons donc comme vraisemblable, dans ce cas aussi, l'hypothèse émise par les auteurs cités plus haut, pour expliquer la sensibilité accrue des plantules développées à l'obscurité.

L'Influence de la Profondeur des Semis sur l'Infection

Dans le cas de la carie du blé, on constate que l'infection est proportionnelle à la profondeur des semis (Radulescu 1959; Savulescu 1951)

Dans les expériences faites en 1954 à 1956, nous avons étudié l'influence de cinq profondeurs de semis sur l'infection du maïs par le *Sorosporium*, à savoir 2, 5, 8, 11 et 14 cm.

TABLEAU IV
Sensibilité des plantules développées à l'obscurité et la lumière

Longueur de la plantule (en mm)	Plantules développées à l'obscurité						Plantules développées à la lumière					
	Plantées dans des vases			Plantées directement dans le champ			Plantées dans des vases			Plantées directement dans le champ		
	Nombre des plantes		% des plantes atta- quées	Nombre des plantes		% des plan- tes atta- quées	Nombre des plantes		% des plantes atta- quées	Nombre des plantes		% des plan- tes atta- quées
	total	attaquées		total	attaquées		total	attaquée		total	attaquées	
5	129	87	67.4	60	46	76.7	95	37	38.9	98	34	34.7
10	168	79	47.0	38	28	73.6	96	28	29.2	84	21	25.0
15	159	70	44.0	50	36	72.0	94	28	29.8	134	19	14.1
20	148	46	31.8	42	28	66.6	114	26	22.8	76	12	15.7

Le semis a été effectué directement dans le champ, dans des trous faits avec un plantoir. Les semences ont été recouvertes jusqu'au niveau du sol avec la terre mélangée avec des spores.

Les résultats indiqués dans le Tableau V montrent que l'attaque du *Sorosporium* augmente continuellement à partir de 2 cm jusqu'à 8 cm de profondeur.

A part l'année 1954, les profondeurs ayant plus de 8 cm ont donné des différences moins nettes.

TABLEAU V

Influence de la profondeur du semis sur l'infection par le Sorosporium

Profondeur du semis (en cm)	Cultivar				
	var. Portocaliu			var. Galben timpuriu	var. I C A R 54
	% des plantes attaquées				
	1954	1955	1956	1956	1956
2	21.2	57.9	38.3	42.5	6.9
5	29.5	66.5	59.5	47.4	9.2
8	30.8	84.6	64.4	60.5	14.3
11	44.1	—	64.1	59.0	13.4
14	43.5	85.6	66.7	60.6	14.6

La Variation de l'Attaque du Sorosporium en Fonction de l'Épaisseur de la Couche infectieuse du Sol.

Comme nous l'avons indiqué antérieurement (Radulescu et al. 1958) l'attaque du *Sorosporium* sur le maïs augmente proportionnellement avec la densité des spores qui se trouvent dans le sol. D'autre part, Nemlienko (1940) attire l'attention sur le fait que l'attaque est de même influencées par l'épaisseur de la couche infectieuse.

Dans une expérience préliminaire effectuée dans des vases en 1958, nous avons mis du maïs à la profondeur de 8 cm, ces semences ont été recouvertes d'une couche de 1, 2, 3 et 4 cm de terre mélangée avec des spores (8 g de spores dans 1 kg de terre), par dessus laquelle on a mis de la terre exempte de spores jusqu'à la hauteur de 8 cm du maïs. Ces vases ont été maintenus dans une étuve à la température de 25–27°C— jusqu'à la levée des plantes, quand on les a mises dans la serre.

Les résultats préliminaires (v. le Tableau VI) montrent qu'à une densité égale des spores se trouvant dans le sol, l'attaque du champignon augmente avec l'épaisseur de la couche infectieuse qui recouvre les semences.

TABLEAU VI

Influence sur l'infection de l'épaisseur de la couche infectieuses traversée par la plantule de maïs

Epaisseur de la couche infectieuse (en cm)	Nombre des plantes		% des plantes attaquées
	Total	Attaquées	
1	102	73	72.5
2	92	77	83.7
3	155	137	88.4
4	116	108	93.1

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PLANT DISEASE CONTROL AND NEW AGRICULTURAL AREAS*

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ABSTRACT

It has been suggested that for new areas of land opened up to settlement, which deviate in their climate from the northern areas in which disease control methods were worked out, special methods of controlling diseases have to be worked out with due regard to their ecology.

A new method of prediction of the occurrence of a disease with unknown biological characters has been suggested. This may help in avoiding unnecessary control work. It has been shown how the timing of vine powdery mildew proved impracticable in Israel because of the differences in climate between Israel and the region in which this method of control has been devised.

A method for predicting the outbreak of potato blight in Israel has been described.

It has been demonstrated that the intensive method of overhead irrigation is injurious to banana plantations and citrus orchards in Israel, as it increases the development of fungus rot.

The great damage caused by sandstorms in the northwestern Negev to potato crops by injuring the leaves and thus increasing the infection by *Alternaria* has been pointed out.

INTRODUCTION

The standard method in use for fighting plant diseases from the inception of plant pathological science was and still is the treatment of plants by disinfection or spraying.

Sorauer (1873) and Jones *et al.* (1926) have already emphasized the limitations of the universally recommended measures in cases when the physiological nature of the host plant or when environmental conditions deviate from the normal. The changes occurring under such circumstances in the time of appearance of the disease often render generally prescribed treatment time-tables futile and sometimes make treatment altogether superfluous.

Parasitic infection takes place in plants only under biologically fixed internal and external conditions. Of external conditions—temperature and air humidity are decisive for the final incidence of plant diseases. If these two factors do not suit the ecological and physiological requirements of the host and of its parasite, no infection can occur. A time-table of control measures worked out for a certain area possessing a definite complex of ecological characters becomes thus invalid when these characters change. Such a gap between the accepted time-table of treating a plant disease and the treatment actually desirable for control of that dis-

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ease is mostly encountered in regions which comprise areas with diverse climatical conditions, such as the United States, Mediterranean countries, etc. Observation on the inadequacy of standard time-tables for fighting plant diseases because of different environmental conditions were made in the United States (Baker and Snyder 1950; Jones *et al.*, 1926; Walker 1950; Yarwood 1950) and Israel (Reichert 1949-50, 1954). Recently we have summarized some observations of this nature made in arid countries with special emphasis on the eastern Mediterranean (Reichert 1949-50).

But in spite of all these critical observations, plant protection services in many countries still recommend the standard treatment schedules worked out for fighting plant diseases without paying attention to the local ecological conditions and thus cause waste of money and manpower.

A radical change has, therefore, to take place in plant disease control in the immense new areas in Asia and Africa with a dry, hot or tropical climate which are now being opened up for settlement. A new time-table for controlling plant diseases as they occur in these regions has to be worked out. The use of the old prescriptions based on results obtained in northern countries may lead to great disappointment as has actually occurred in Israel (Reichert 1949-50). Plant pathology has to become aware of the fact that its great achievements in the control of plant diseases were made in cool and humid climates and in no way may they simply be transferred to hot and dry or tropical climates.

Some results of our search for new methods of adapting plant pathology to xerothermic climates are herewith communicated. Some of the methods may also be applied to all kinds of climates. The various aspects to be discussed are as follows:

1) Prediction of occurrence of the plant disease; 2) Prediction of outbreaks of plant diseases; 3) Timing of treatment; 4) Intensive agriculture and plant diseases; and 5) Sandstorms and plant diseases.

PREDICTION OF OCCURRENCE

Starting our plant pathological work in 1922 in Palestine, we discovered that all its modern vine growers had been treating their vineyards for 40-50 years with iron sulphate against Anthracnose disease (*Gloeosporium ampelophagum* or *Elsinoe ampelinum*), making a dormant application in winter and several sprayings in summer. This treatment was recommended by French instructors to whom this disease was familiar from France. Our examination of leaves and shoots did not reveal any Anthracnose fungus at all, but before advising the vine growers to stop treatment we wanted to ascertain definitely that the disease was absent. Lacking data on the biological characters of the fungus, we made use of our new phytopathogeographical method described elsewhere (Reichert 1950, 1958/b) and prepared a distributional map of the disease in various countries (Figure 1). The pat-



Figure 1
Distribution of vine anthracnose (*Elsinoe ampelinum*)

tern of distribution obtained showed us that the disease occurred only in areas with a humid climate or in dry areas with a humid micro-climate. Thus the disease occurred in Europe only in its western and medium parts where humidity is high in summer. It does not occur at all in dry parts of eastern Europe including Russia (Naumov 1934). The disease does certainly occur in South America with its tropical climate and in North America it is limited to the southeastern vine region but it does not occur in California (Reichert 1958/a). The disease attacks vine under humid conditions also in South Africa (Du Plessis 1940).

The humidity loving character of the Anthracnose fungus has also been varified by preparing a distributional map of all the genus *Elsinoe* numbering 175 species (Figure 2)*. All these species are mainly spread in tropical and to a smaller extent in cooler countries where humidity is very high. Only after this final verification of the dependence of the Anthracnose fungus on humidity, did we advise the growers to cease their treatment of the vine against this disease. Growers were at first opposed but were later glad to follow this advice and were spared a lot of expenses.

This new method of defining the ecological requirements of a pathogen may be used for all climates in predicting the occurrences of diseases.

PREDICTION OF OUTBREAKS

Israel is growing a winter crop of tomatoes in the Jordan Valley where temperatures do not in normal years fall to below zero. Tomatoes are sown in August–September and when certain conditions prevail the plants become epidemically infected by

* This work could be carried out thanks to the studies of the genus *Elsinoe* by Betancourt and Yenkin (1936–58).



Figure 2
Distribution of the genus *Elsinoe*

Phytophthora blight, suffering great losses. As such epidemics do not occur each year, we were anxious to find the factor which brings about these epidemics in order to be able to forecast this outbreak and to advise farmers to spray at the right time. Observations over a number of years taught us that the tomato blight becomes especially destructive when winter rain is excessive. It is not the total amount of precipitation that matters, but its distribution in various months. We have found that when the amount of rain in November-December reaches 200 mm one has to expect an epidemic. if the rain is less than 125 mm in these 2 months, no serious blight attack is to be expected. If all the 200 mm fall at the end of December, this is not conducive to epidemic development of the disease. The amount of rain has to be equally divided between these 2 months (Figure 3). This method is not new. Cook (1947) in Virginia used also rain as a criterion of forecasting *Phytophthora* blight. This method has thus been adapted to our conditions (Reichert and Rotem 1961).

Another method of prediction of an outbreak of a disease for the following year was demonstrated by our wheat disinfection experiment against bunt or covered smut (*Tilletia tritici*) which causes in certain years considerable losses (Reichert 1928). Explanation for the intermittent occurrence of this disease in Israel and prediction of the years of infection seemed to us very important. Our experiments have shown that heavy infection occurs when seeds are sown in wet soil and when total precipitation during the short period from sowing to germination of the seeds is higher than 100 mm. In years in which rainfall during this period of germination is low, no infection of the seeds by covered smut occurs. Such seeds remain usually clean and do not have to be treated for next year's sowing. In that way we were able to forecast the outbreak or the absence of disease for the next year.

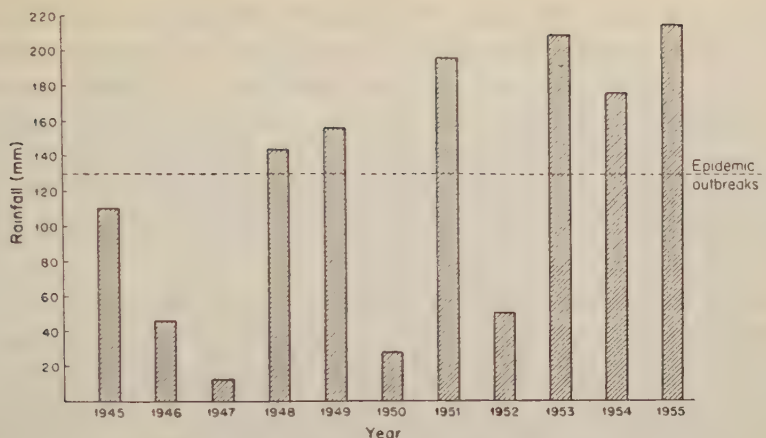


Figure 3

Rainfall in 11 years from middle November to end of December in Jordan Valley influencing tomato blight. Epidemic outbreaks occurred when rainfall exceeded 125 mm.

TIMING OF TREATMENT

A good example for the necessity of changing the time-table of treatment accepted in northern climates to suit arid conditions is furnished by the powdery mildew (*Ucinula necator*) of vine in Israel. In most vineyards of the northern cooler climates sulphur treatments are applied to the vine at the beginning of the season when shoots reach the size of 20–50 cm, without regard to the appearance of signs of infection. The powdery mildew in Israel's coastal plain starts only after flowering when the fruits begin to set. Only when rain is plentiful during April–May do mildew attacks start earlier. In normal years no necessity for treatment, therefore, exists even when the shoots of the vine reach a size of 50–150 cm as long as flowering has not started.

By changing and adapting the time-table of treatments accepted in northern countries and adapting it to our conditions, we were able to reduce the number of sulphur applications to be applied by our vine growers from five to only two or three.

INTENSIVE AGRICULTURE AND PLANT DISEASES

It is not only time-tables prepared for the control of plant diseases in other countries that have to be changed where they do not suit the climatical conditions of new areas. The introduction of intensive methods of agriculture must likewise take into account the specific ecological requirements of the new area. The following example illustrates this point.

I refer to the overhead sprinkling which is so intensively used in the United States and has become increasingly popular in Israel in the last decade. I would like to mention two examples. The first is our banana plantations. Usually banana plantations are irrigated by flooding. The banana fruits then suffer from a certain rot caused by *Dothiorella*, but the damage is not particularly great. After the overhead irrigation method was introduced the fruit rot of the bananas increased considerably. An exact experiment carried out recently showed that the percentage of fruit rot may increase 7–17 times (Chorin and Rotem 1961).

The second disease which becomes more serious after the introduction of overhead sprinkling was the soft rot of citrus trees caused by *Ganoderma* and other higher fungi which involve the whole inner part of the stem (Reichert 1932). The disease was previously a very rare phenomenon among our citrus trees which were usually irrigated by the furrow system, but after the use of overhead irrigation it became a very serious plague. In one instance, in a grove that had previously shown almost no disease, the examination of 100 trees at random after 3 years of irrigation by the overhead method, showed that 54 trees were severely infected whereas 46 were moderately affected.

These two examples show that intensive methods, good as they are, cannot be simply introduced without consideration of the ecological requirements of the disease.

SANDSTORMS AND PLANT DISEASES

That vicissitude of climate may influence the syndrome of plant diseases is clearly demonstrated by the incidence of *Alternaria solani* early blight of potatoes in Israel. This leaf disease appears in all parts of Israel and former Palestine without causing serious damage to the plants, but on the other hand this disease assumes a serious form in the semi-arid desert parts of Israel — in the northwestern Negev — where leaves and plants are totally dried up. A thorough survey (Rotem 1959) revealed that the reason for the increased violence of the disease in the Negev are the sandstorms blowing in this part of the Negev during autumn and winter. The leaves of the plant are injured by sand particles so that the *Alternaria* fungus is able to penetrate them and to affect the whole plant. An examination of the leaves attacked by *Alternaria* in the Negev region revealed a thick layer of sand sticking to the leaves. Leaves of potatoes grown in other parts of the country, where sandstorms are non-existent, were on the whole clean. Experimental exposure of potatoes to artificially induced sandstorms corroborated the fact that the leaves bruised by the sand particles were much more prone to infection than others. As a result of this study, it appears that the most practical approach to the protection of potatoes in the northern region of the Negev from *Alternaria*, may be their protection from sandstorm injury.

DISCUSSION AND CONCLUSIONS

The facts described above concerning the presence or absence of plant diseases in xerothermic regions like Israel warrant the following conclusions:

1) Disease control schedules worked out in one climatical region cannot always be simply copied and applied to other regions with a different climatical character. The timing of control must always be based on the ecological data of a given country. If climatical conditions in the new area differ from those of the old one, the whole time-table of control measures loses its value. Each area has to work out its schedule of control in accordance with the local environment.

2) In the intensification of agriculture, due consideration must be given to the effect of new methods of irrigation on potential plant diseases. This we could learn from the experiments with overhead sprinkling of banana and citrus trees in Israel. This kind of irrigation induced serious hazards into these two important crops.

3) Plant pathology faces difficulties not known until now in the northern countries, when it starts its work in the hot desert regions where sandstorms are mostly blowing during certain times of the year. These sandstorms create new problems of infection of crops which have to be met by special devices.

4) The above-described method for prediction in certain new regions with known climate of the occurrence of a disease, the ecological amplitude of which is not known, on the basis of its geographical and ecological distribution has been found by us to be applicable to many other cases. This method is quite new. It differs from the accepted method of prediction of outbreak described in phytopathological literature. The latter method deals with diseases already existing in the region, whereas our new method aims at forecasting the possible occurrence of diseases not yet known in the region and preventing their penetration into the region. This method enables intensive agriculture to develop its disease control system and what is still more important to base its quarantine work on biological and not only mechanical principles.

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PHYSIOLOGICAL ASPECTS OF INJURY CAUSED BY *XANTHOMONAS CAMPESTRIS* IN VASCULAR TISSUE

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ABSTRACT

Attempts were made to investigate the physiological nature of black rot in crucifers caused by *X. campestris*. The wilting symptoms of the disease have been traced to the formation of plugs in the water-conducting system of the infected plants. Some of the components which form these plugs are pectin, melanins, and wound gum. In culture solution the bacteria were found to produce an extracellular enzyme, similar in its action to polygalacturonidase. Filtrates from such culture solution caused the production of plugs in kohlrabi seedlings, when sucked through the cut stems. The same effects were caused by solution of commercial PG preparation. The latter was more active, causing more rapid wilt.

INTRODUCTION

Black rot, the disease discussed in this article, is characterized by yellow necrotic triangular lesions at the leaf margins, blackening of the vascular tissue and necrotic area.

From his experiments Smith (1911) concluded that the injury caused by this disease was due to the blocking of water passage in injured vascular tissue. Similar blocking caused by *Fusarium* sp. in tomato was related to the production of polygalacturonidase, which, in turn caused a breakdown of pectic substances in the vascular tissue. The breakdown products enter the xylem vessels, where they form plugs (Gothoskar *et al.*, 1955; Pierson *et al.*, 1955; Scheffer and Walkes, 1953). It occurred to us that the same or a similar process might also take place in the case of black rot. Therefore, attempts were made to investigate the physiological nature of the injury in the vascular tissue.

EXPERIMENTS AND RESULTS

The experiments were carried out at the Department of Plant Pathology, The Agricultural Research Station, Rehovot-Beth Dagon. The plants tested were: naturally infected cauliflower, cabbage and kohlrabi collected in neighbouring fields, healthy seedlings grown in the greenhouse, and artificially infected seedlings.

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Anatomical and histochemical studies of stems and petioles

The xylem vessels of naturally infected plants were plugged with a yellowish-brown to red substance (Figures 1a, 1b), while no plugs were observed in vessels of healthy plants (Figures 2a, 2b).

Histochemical tests (Kertesz, 1951; Rawlings and Takahashi, 1952; Rawlings, 1933; Gurr, 1952; Lillie, 1953) were used to analyze the plugs, giving the following results:

TABLE I
Histochemical Standard tests

Reactions and identifying chemicals	Results	Probable plug material	Reference
Ruthenium red FeCl	red blue	pectin "	Kertesz 1951 Rawlins and Takahashi 1952
Phloroglucinol/HCl	red	wound gum and/or lignin	Rawlins 1933
Mäule reaction	red	wound gum	Rawlins 1933
Gurr staining	black green	melanins	Gurr 1952
H ₂ O ₂ :	clearing	melanins	Lillie 1953

The above reactions show that plugs contain among other materials: pectin, wound gum and melanins.

Physiological studies. The formation of polygalacturonidase (PG) by *X. campestris* in the culture solution was detected by the viscosimetric method devised by Smith (1958). To prove that PG caused the above blocking of the vascular tissue, derooted kohlrabi seedlings were immersed in a filtered substrate in which *X. campestris* had previously been grown. Control experiments were run in filtered substrate which had been boiled for 10 minutes, in sterile substrate and in pure water. After 3 days the seedlings in the unboiled and boiled substrate were wilting, while those in water and sterile substrate were turgid and green. Blackening of veins was not observed in any of the treatments. Five days after the start of the experiment microscopical examination showed plugs in the two wilted groups, but none in the other two. The experiment was repeated with commercial PG, using a 0.5% solution. Controls were run with boiled preparation and with water. The results were essentially the same, but the unboiled commercial preparation was apparently more effective, since wilting occurred within 2 days, and blackening of the stems and, sometimes, also in the leaves, was observed after 5 days in 11 out of 14 treated plants.

The number of plugged xylem vessels in each stem was determined by serial sectioning. The results are given in Table II.

TABLE II
Number of plants with plugged xylem vessels

Treatment	Number of plants tested	Number of plants with			
		No plug. ves.	1-5 plug. ves.	5-10 plug. ves.	> 10 plug. ves.
Water	14	14	0	0	0
Sterile substance	10	10	0	0	0
Boiled substance	10	2	3	3	2
Unboiled substance	10	0	1	3	6
Boiled PG	14	0	2	5	7
Unboiled PG	14	0	1	0	13

The above table gives us the following major results:

1. Both commercial and bacterial PG cause plugging of the vascular tissue.
2. The reaction of the bacterial PG was weaker than that of the commercial variety. Although there is no decisive proof and this might be due to either qualitative or quantitative differences, it seems to be the result of higher concentration.
3. The partial inactivation of the bacterial and commercial PG caused by boiling could be due to insufficient heating (10 mins. only), since Pierson *et al.* (1955) have shown that autoclaving the enzyme preparation causes its full inactivation. However, Echandi *et al.* (1957) have found similar heat resistance in a pectolytic enzyme derived from *Erwinia*.

ACKNOWLEDGMENT

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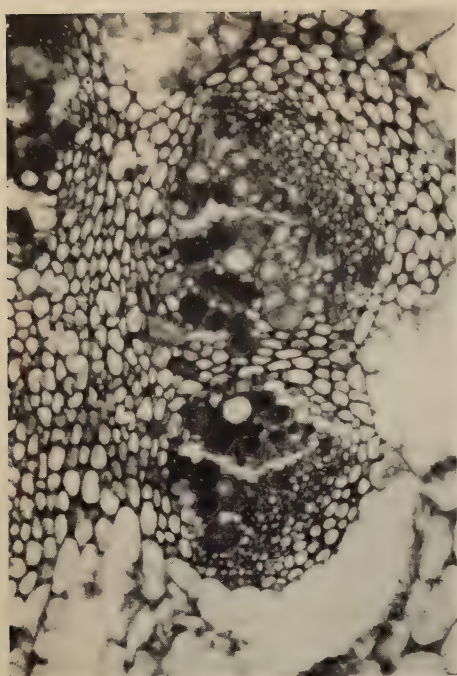


Figure 1a

Cross section in a stem of an infected plant, showing dark substance plugging the xylem vessels, magnified $\times 100$.

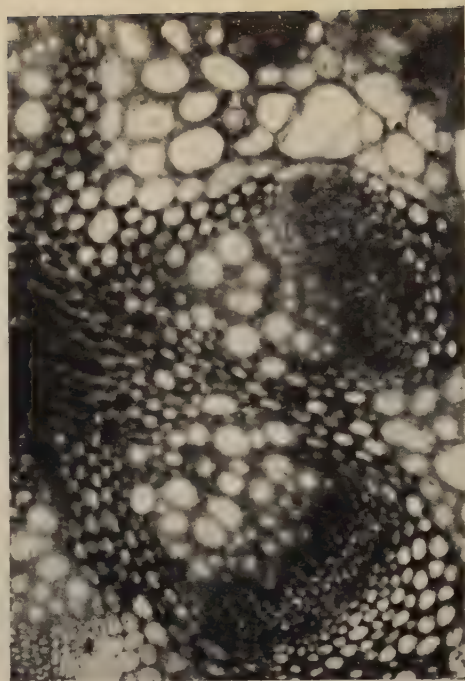


Figure 1b

The same cross section as in Figure 1a, magnified $\times 450$

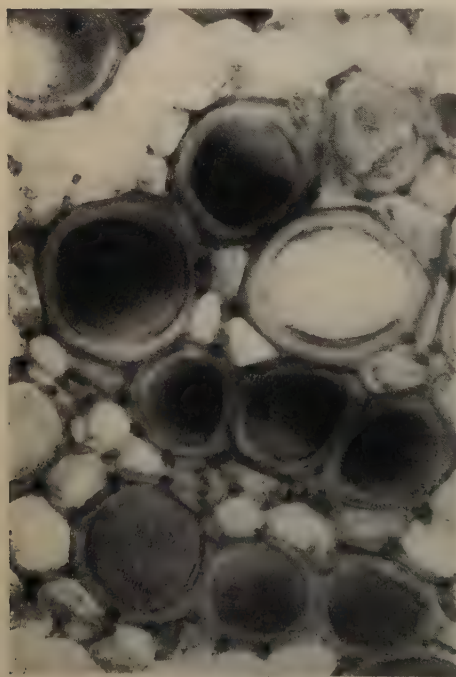


Figure 2a

Cross section in a stem of healthy plant, no plugs are seen, magnified $\times 100$.

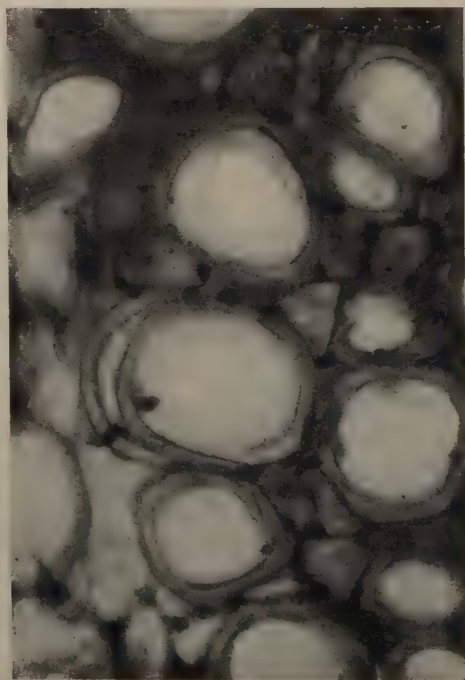


Figure 2b

The same cross section, as in Figure 2a, magnified $\times 450$.

QUELQUES MICROMYCETES NOUVEAUX POUR LA FLORE MYCOLOGIQUE DE LA REPUBLIQUE POPULAIRE ROUMAINE

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ABSTRACT

Ten Micromycetes, parasiting on trees and shrubs, are recorded and some of their morphological characteristics are given. One new species, *Pyrenophora rayssiae*, is described.

Les recherches sur la flore mycologique de la R.P.R. sont bien anciennes. Mais des études importantes ont été faites assez récemment et les bases documentaires pour ces études ont été établies par M. le prof. Traian Savulescu. Dans ce domaine des recherches Mlle Tscharna Rayss a pris part comme collaboratrice de M. Savulescu en enrichissant spécialement nos connaissances sur les champignons de la famille des Péronosporacées.

Comme hommage au travail par Mlle Rayss, nous lui dédions cette petite note qui représente la XVIII-ème note sur la connaissance des Micromycètes de la R.P.R. et dans laquelle nous décrivons un espèce nouvelle, le *Pyrenophora rayssiae* Sandu-Ville, sp. nov.

1. *Pleospora clematidis* Fuck., Symb.myc.132.1869.

Sur des rameaux desséchés de *Clematis vitalba* L., à Muncelul, distr. Panciu, le 3.8.1959. Périthèces sphériques, enfoncés dans l'écorce qu'ils percent d'un petit col conique, aplatis à leur base et mesurant: $160-400\mu$; les asques cylindriques: $110-120 \times 9-11\mu$; les spores disposées sur un seul rang, allongées-fusiformes, à cinq cloisons transversales, rarement à une seule cloison longitudinale incomplète qui coupe au travers une seule cellule médiane, étranglées d'une façon évidente, surtout à l'endroit de la cloison médiane transversale; jaune-brunâtre; $18-22 \times 5-6\mu$. Les paraphyses qu'on y trouve sont plus longues que les asques.

2. *Pyrenophora rayssiae* Sandu-Ville sp. nov.

Peritheciis dispersis, immersis, carbonaceis, contextu parenchymatico $15-20\mu$ crasso, globosis-depressis: $200-320\mu$ latis et $150-180\mu$ altis, cum poro fere cylindraceo 80μ lato et 32μ alto, apice pilis brevibus munito. Ascis cylindraceis, leniter clavatis, breve stipitatis, octosporis: $75-100 \times 10-12\mu$; sporidiis apice irregulariter distichis basim monostichis, fusiformibus, primo stramineo-brunneis, dein fusco-

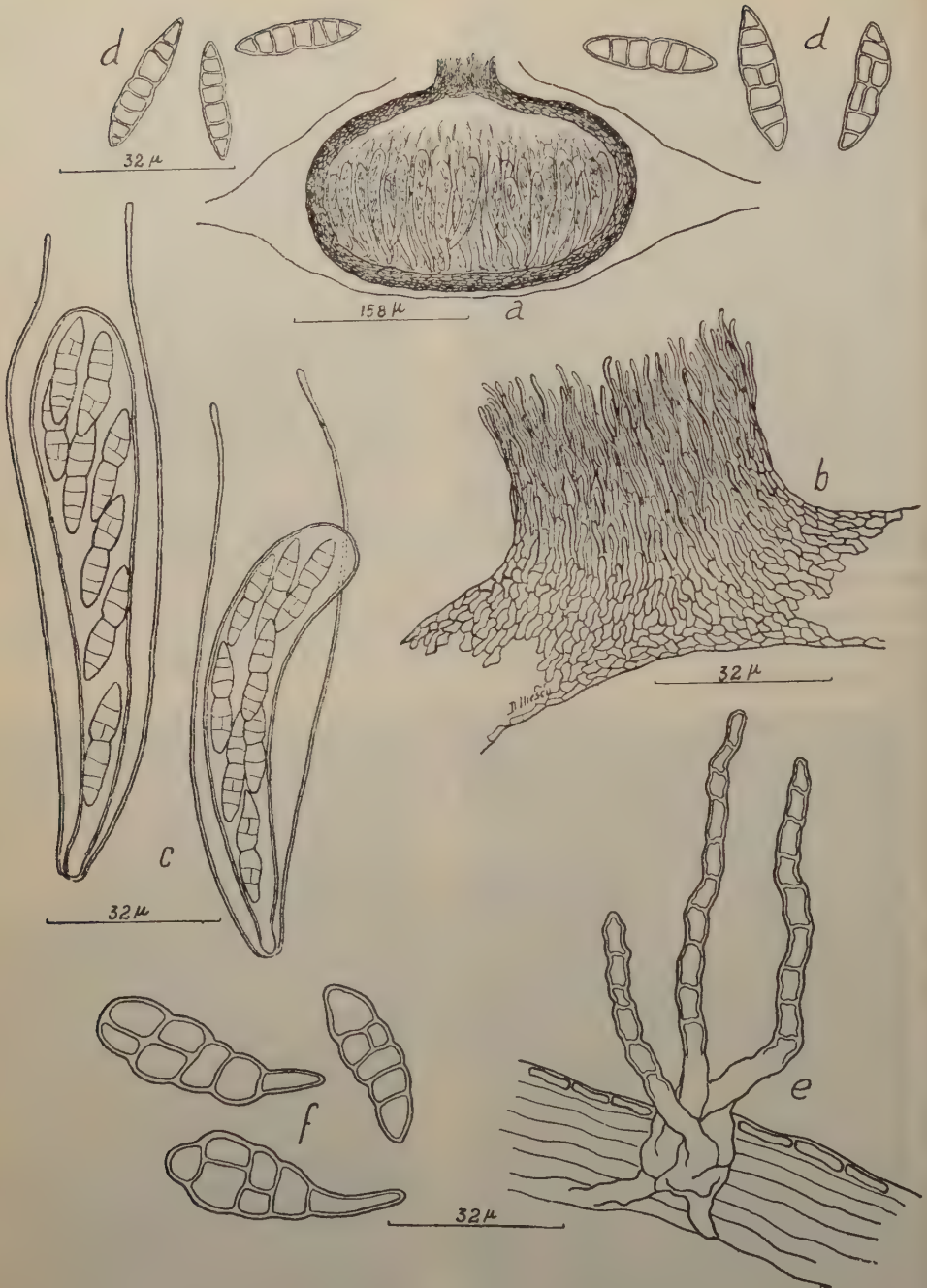


Figure 1

Pyrenophora rayssiae Sandu-Ville: a. section dans un périthèce; b. le col d'un périthèce; c. asques avec des ascospores; d. ascospores isolées; e. conidiophores; f. conidies.

brunneis, 5-7, plerumque 6-7 transverse septatis et hic leniter constrictis et 1-2 incompleto-longitudinaliter septatis: $21-27 \times 5-7.5\mu$. Paraphysibus numerosis, filiformibus, ascis longioribus. Status conidiophorus ad *Macrosporium* pertinet.

Hab. in caulibus siccis *Solidaginis canadensis* L., prope Iasi, R.P.R. ubi, 21.6.1959. legimus et in honorem Prof. Tscharna Rayss dicamus. (Fig. 1)

Au premier coup d'oeil le champignon ressemble à une espèce de *Leptosphaeria*, mais se distingue de ce genre par quelques-unes de ses spores pourvues d'une cloison longitudinale incomplète. On pourrait rapporter ce champignon à une espèce du genre *Pleospora* par les caractères des ses spores, mais nous croyons qu'il serait mieux de le déterminer comme un *Pyrenophora* parce que l'ostéolum apparaît pileux à cause des filaments qui s'entremêlent pour former le col des périthèces et qui restent ensuite libres sur quelque distance. Sur les tiges de *Solidago canadensis* étudié on trouve aussi de nombreux conidiophores formant des touffes denses; ils sont noeux, flexueux, d'un brun-foncé: $32-70 \times 4,5-6\mu$; les conidies sont du type *Macrosporium*, à 3-5 cloisons transversales, ayant une cloison longitudinale incomplète, distinctement étranglées à l'endroit des cloisons transversales. Leurs dimensions varient entre $22-36 \times 12-15\mu$. La forme conidienne ressemble beaucoup à *Macrosporium commune* Rab. qui est considéré aussi comme forme conidienne du *Pleospora herbarum* (Pers.) Rab. Le champignon ressemble beaucoup à *Pyrenophora phaeomoides* Sacc., mais s'en distingue par les poils qui se trouvent autour de l'ostéolum et qui ne sont pas distinctement différenciés, par ses périthèces plus grands (non seulement 250μ), par les asques plus minces (n'arrivant pas à $15-18\mu$), par les spores à 5-7 cloisons transversales (non seulement 5) et qui sont un peu plus longues (non seulement $18-21\mu$) et plus minces (n'arrivant pas à $8-11\mu$).

3. *Cucurbitaria naucosa* Fuck., Symb.myc.173.1869.

Sur les rameaux desséchés d'*Ulmus foliacea* Gilib., à Dumbraveni, district Suceava, le 14.7.1959. Les asques sont cylindriques, courtement pédunculés: $115-130 \times 12-16,5\mu$; les spores à 3-5-7 cloisons transversales dont trois sont plus distinctes, avec une cloison longitudinale incomplète: $20-24 \times 7,5-10\mu$. De nombreuses paraphyses filiformes entourent les asques.

4. *Massarina eburnea* (Tul.) Sacc., Syll.Fung.2.153.1883.

Syn.: *Massaria eburnea* Tul., Sel. Fung. Carp. 2. 239 1863.

Sur des rameaux desséchés de *Corylus avellana* L., à Durau, district Piatra Neamt, le 4.8.1959. Les périthèces sont quelquefois dispersés mais plus fréquemment ils sont associés en groupes et même soudés par leurs parois latérales; ainsi ils apparaissent comme enfoncés dans un stroma, sont sphériques-aplatis ayant un col conique qui perce l'épiderme; ils mesurent jusqu'à 580μ de diamètre. Les asques sont cylindriques, quelque peu en massues, courtement pédunculés: $115-160 \times 18-24\mu$. Les spores sont disposées obliquement sur un seul rang ou quelquefois sur deux rangs, ont trois cloisons transversales et sont nettement étranglées à l'endroit de celles-ci surtout au milieu. Dans chaque cellule de la spore se trouve une grande goutte d'huile qui occupe à peu près le volume entier de la cellule. Les spores sont entourées d'une couche gélatineuse bien évidente et assez épaisse, hyaline et mesurent: $30-35 \times 7,5-10\mu$. Les paraphyses sont filiformes, plus longues que les asques.

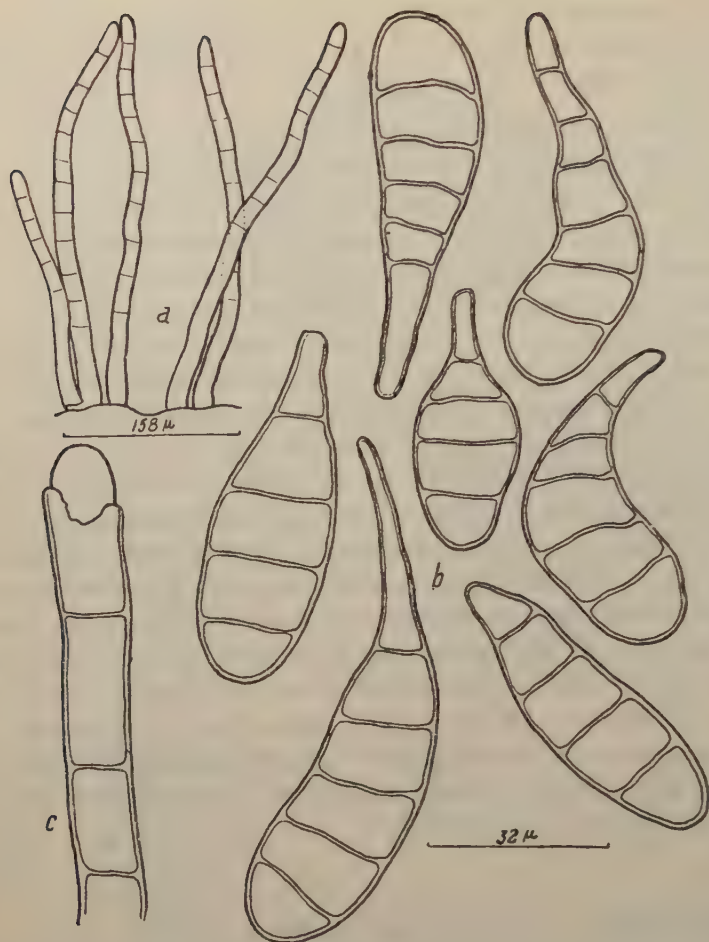


Figure 2

Helminthosporium appendiculatum Corde: a. conidiophores; b. conidies; c. une conidie jeune sortant d'une cellule a l'extrémité du conidiophore.

Ce champignon est cité par Winter uniquement sur des rameaux de *Fagus* et de *Betula* et Migula l'indique seulement sur *Fagus*. Ainsi le *Corylus avellana* L. doit être considéré comme plante nourricière nouvelle pour cette espèce. Une autre espèce de *Massarina*, le *M. eburnoides* Sacc., est indiquée sur le noisetier, mais elle possède des périthèces toujours dispersés, des asques plus petits ($120-130 \times 18-20\mu$) et des ascospores plus épaisses ($12-15\mu$ de diam.)

5. *Phoma ebuli* Schultz. et Sacc., Micromyc. Slavon.no.39.1884.

Sur des tiges desséchées de *Sambucus ebulus* L., à Muncelul, district Panciu, 3.8.1959. Les pycnides sont enfoncées dans l'écorce qu'elles percent d'un petit ostéolum conique: $130-200\mu$; les pycnosporos sont cylindriques et très souvent un peu ovoidales: $2,5-4,5 \times 2\mu$.

6. *Phomopsis rudis* (Sacc.) v. Höhnelt sec. Diedicke in Kr.Fl.Mark Brandenb. 9. 253.1915

Aux extrémités des rameaux desséchés de *Cytisus hirsutus* L., à Muncelul, district Panciu, le 3.8.1959. Les pycnospores sont cylindriques peu pointues au sommet: $6-9 \times 2\mu$; les conidiophores mesurent $21-30 \times 1,5-2\mu$.

Dans la bibliographie, le champignon n'est cité que sur *Cytisus alpinus* Mill. et *C. laburnum* L. de sorte que le *C. hirsutus* L. doit être considéré comme plante nourricière nouvelle pour cette espèce.

7. *Ascochyta aquilegiae* (Rab.) v. Höhnelt in Ann.Myc.2.406.1905.

Syn: *Phyllosticta aquilegiae* Rab. et Pat. in Fungi gallici no. 2849 et Rev. myc. 5.28.1883.

Sur les feuilles d'*Aquilegia vulgaris* L., à Durau, district Piatra Neamt, le 4.8.1959. Pycnides: $75-176\mu$; pycnospores cylindriques, fortement agglutinées: $7,5-16 \times 3-4,5\mu$.

En masse les spores apparaissent un peu colorées en jaune, caractère qui a déterminé Diedicke à proposer que cette espèce soit répartie au genre *Ascochyta*.

8. *Septoria xylostei* Sacc. et Winter in Hedwigia, 181.1883.

Sur les feuilles de *Lonicera tatarica* L., à Dumbrăveni, district Suceava, le 14.7.1959. Les pycnides sphériques apparaissent sur les deux faces des feuilles et mesurent: $60-100\mu$; les spores sont agglutinées au début, filamenteuses, peu courbées et contiennent plusieurs gouttes d'huile. Elles mesurent: $40-56 \times 1,5\mu$.

9. *Coryneum bicornis* E. Rostr., Tidsskr. 271.1889.

Sur les aiguilles d'*Abies alba* Mill., à Durau, district Piatra Neamt, le 4.8.1959. Les dépôts des spores sont petits, noirs, ponctiformes et se trouvent sur la partie inférieure des aiguilles. Les spores ont 3 à 5 cloisons transversales (la plupart seulement 3). Les cellules terminales sont hyalines, courbées comme des cornes: $20-27 \times 6-7,5\mu$. Dans le matériel étudié par nous les conidies mesurent jusqu'à 27μ de longueur et non seulement 24μ comme il est indiqué dans la diagnose, se qui peut être rapporté aux conditions différentes du milieu.

10. *Helminthosporium appendiculatum* Corda, Ic.fung.i.12.1837.

Sur les rameaux desséchés d'*Acer campestre* L., à Soveja, district Vrancea, le 3.8.1959. Les conidiophores sont droits ou peu courbés, non ramifiés, isolés ou en fascicules de 3 à 4 et même davantage, d'un brun foncé à la base tandis qu'au sommet ils sont moins colorés et présentent des cloisons transversales distinctes, à l'endroit desquelles elles ne sont pas étranglées: $320-600 \times 12-15\mu$; les conidies sont cylindriques, en massues ou plus souvent simplement en massues, amincies à la base dans un pédoncule court et moins coloré; elles sont fréquemment courbées, ayant de 3 à 7, pour la plupart 4 à 5 cloisons transversales qu'on distingue mal à cause de la coloration foncée des conidies; leur dimension est: $45-70 \times 15-18\mu$. On peut observer au sommet de certains conidiophores comment les jeunes conidies à peu près incolores et non cloisonnées sont éliminées de l'intérieur de la dernière cellule; ainsi les conidiophores de cette espèce peuvent être considérés comme des phyalides et les conidies comme des endoconidies (Fig. 2).

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LES ESPECES DE *PERONOSPORA* CORDA PARASITES SUR LES LEGUMINEUSES DE LA REPUBLIQUE POPULAIRE ROUMAINE

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ABSTRACT

In the Rumanian Republic have been found 29 species of *Peronospora* parasiting 43 species of the Leguminosae family. Five of them have been described for the first time by Tr. Savulescu and T. Rayss: *Peronospora galegae* on *Galega officinalis*, *P. romanica* on *Medicago falcata* and *Medicago falcata* var. *romanica*, *P. lathyri-aphacae* on *Lathyrus aphaca*, *P. lathyri-hirsuti* on *Lathyrus hirsutus* and *P. lathyri-versicoloris* on *Lathyrus versicolor*. Out of these 29 species, 6 have been found on *Trifolium*, 5 on *Vicia* and 5 on *Lathyrus*. Ten of these *Peronospora* species belong to the Section *Leiothecae* subsect. *effusae*, one to the Section *Calothecae* subsect. *verrucosae* and 9 to the Section *Calothecae* subsect. *reticulatae*. Nine species could not be attributed to any section because their oospores are yet unknown.

Dans les travaux sur les Péronosporacées de Roumanie, publiés par Tr. Savulescu, seul ou en collaboration avec le Prof. T. Rayss, on mentionne 29 espèces du genre *Peronospora* Corda, parasites sur des plantes de la famille des Légumineuses. Certaines espèces sont citées aussi dans les travaux des chercheurs Oescu et Radulescu (1933 a, b), C. Sandu-Ville et I. Radulescu (1952, 1954) et Lazar (1958) qui ont étudié la mycoflore de la Moldavie. Au total on a trouvé 29 espèces de *Peronospora* sur 43 espèces de Légumineuses. Parmi ces 29 espèces de *Peronospora* parasites sur les Légumineuses, 5 espèces ont été décrites pour la première fois par Tr. Savulescu et T. Rayss, à savoir: *Peronospora galegae* sur *Galega officinalis* L. (1930), *P. romanica* sur *Medicago falcata* L. et *M. falcata* var. *romanica* (Prod.) Hayek, (1932) *P. lathyri-aphacae* sur *Lathyrus aphaca* L., (1930) *P. lathyri-hirsuti* sur *Lathyrus hirsutus* L., (1934) *P. lathyri-versicoloris* sur *Lathyrus versicolor* (Gmel.) Beck. (1932)

De ces 29 espèces de *Peronospora*, la plupart sont parasites sur des espèces de *Trifolium* (6 espèces), sur des espèces de *Vicia* (5 espèces) et sur des espèces de *Lathyrus* (5 espèces).

Groupées par sections et soussections, les espèces de *Peronospora* parasites sur les Légumineuses sont réparties comme suit:

Sect. *Leiothecae* Schröter
soussect. *effusae* De By.

<i>P. astragalina</i> Syd.	— conidies de 14–30 × 12–27 μ
<i>P. fabae</i> Jacz. et Serg.	— conidies de 18–30 × 14–21 μ
<i>P. galegae</i> Savul. et Rayss	— conidies de 14–31 × 14–27 μ

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<i>P. lotorum</i> Syd.	— conidies de 17–35 × 15–29 μ
<i>P. aestivalis</i> Syd.	— conidies de 18–31 × 16–23 μ
<i>P. ruegeriae</i> Gäum.	— conidies de 21–34 × 25–28 μ
<i>P. trifolii-alpestris</i> Gäum.	— conidies de 18–26 × 17–24 μ
<i>P. trifolii-arvensis</i> Syd.	— conidies de 16–21 × 15–29 μ
<i>P. trifolii-minoris</i> Gäum.	— conidies de 16–24 × 15–24 μ
<i>P. trifolii-repentis</i> Syd.	— conidies de 22–29 × 20–24 μ

Sect. Calothecae De Bary

sousesect. verrucosae A. Fischer

P. ononidis Wilson

— conidies de 21–28 × 15–20 μ

sousesect. Reticulatae A. Fischer

P. manshurica (Naum.) Syd.

— conidies de 14–30 × 14–29 μ

P. lathyri-aphacae Savul. et Rayss

— conidies de 12–25 × 11–20 μ

P. lathyri-hirsuti Savul. et Rayss

— conidies de 12–27 × 11–24 μ

P. orobi Gäum.

— conidies de 19–31 × 14–18 μ

P. romanica Savul. et Rayss

— conidies de 13–28 × 12–23 μ

P. pisi Syd.

— conidies de 18–3g × 15–20 μ

P. mayori Gäum.

— conidies de 16–30 × 11–21 μ

P. sepium Gäum.

— conidies de 10–31 × 9–29 μ

P. viciae (Berk.) Gäum.

— conidies de 16–24 × 14–20 μ

Espèces qui ne peuvent pas être réparties avec certitude à une certaine section à cause du fait que les oospores ne sont pas connues:

P. coronillae Gäum.

— conidies de 19–30 × 15–24 μ

P. lathyri-versicoloris Savul. et Rayss

— conidies de 16–34 × 10–23 μ

P. senneniana Frag. et Sacc.

— conidies de 21–39 × 15–22 μ

P. meliloti Syd.

— conidies de 18–30 × 15–25 μ

P. tetragonolobi Gäum.

— conid es de 12–36 × 11–27 μ

P. pratensis Syd.

— conidies de 19–37 × 12–29 μ

P. trifolii-hybridi äaum.

— conidies de 11–30 × 11–27 μ

P. trigonellae Gäum.

— conid es de 18–27 × 12–18 μ

P. viciae-sativae Gäum.

— conidies de 20–27 × 18–22 μ

Nous donnons ici l'énumération des espèces de *Peronospora* parasites sur les Légumineuses, de la République Populaire Roumaine, en indiquant les plantes-hôte sur lesquelles elles ont été trouvées, ainsi que leur distribution géographique.

1. *Peronospora aestivalis* Sydow sur *Medicago lupulina* L.

Rég. Iasi – Copou, Aroneanu, Valea Lupului ; rég. Bacau – Bicz, P. Neamt ; rég. Bucuresti – Marculesti ; rég. Bucuresti – Baneasa ; rég. Craiova – Lainici ; rég. Brasov – Timisul de Sus, Fagaras ; rég. Cluj – Aiud ; rég. Mures – autonoma maghiara – Cheile Bicazului.

Sur *Medicago minima* (L.) Bartal.

Reg. Iasi – Copou, Miroslava, Sorogari ; reg. Ploesti – Istrita, Buzau ; reg. Bucuresti – Comana ; reg. Dobrogea – Murfatlar ; reg. Hunedoara – Orastie.

Sur *Medicago sativa* L.

Reg. Iasi ; reg. Bacau – Roman ; reg. Ploesti – Buzau ; reg. Bucuresti – Baneasa, Floreasca, Peris, Manastirea, Comana ; reg. Dobrogea – Cernavoda ; reg. Arad – Minis.

2. *Peronospora astragalina* sur *Astragalus onobrychis* L.

Reg. Iasi – Ciurea, Vladiceni.

3. *Peronospora coronillae* Gaum. sur *Coronilla scorpioides* (L.) Koch.

Reg. Dobrogea – Murfatlar.

Sur *Coronilla varia* L. Reg.

Reg. Iasi – Horpaz; reg. Ploesti – Izvoare; reg. Arges – Badulesti; reg. Cluj – Cheile Turzii;
reg. autonoma maghiara – Ghilcos, Surduc.

4. *Peronospora fabae* Jacz. et Serg. sur *Vicia faba* L.

Reg. Ploesti – Buzau.

5. *Peronospora galegae* Savul. et Rayss sur *Galega officinalis* L.

Reg. Argeş – Nucet; reg. Ploesti – Izvoare; reg. Dobrogea – Periprava, Letea.

6. *Peronospora lathyri-aphacae* Savul. et Rayss sur *Lathyrus aphaca* L.

Reg. Bucuresti – Oltenita, Comana.

7. *Peronospora lathyri-hirsuti* Savul. et Rayss. sur *Lathyrus hirsutus* L.

Reg. Iasi – Letcani; reg. Ploesti – R. Sarat; reg. Bucuresti – Catelu.

8. *Peronospora lathyri-versicoloris* Savul. et Rayss sur *Lathyrus versicolor* (Gmel.) Beck.

Reg. Suceava – Dorohoi, Saveni; reg. Bucuresti – Comana.

9. *Peronospora lotorum* Syd. sur *Lotus corniculatus* L.

Reg. Iasi – Copou; reg. Ploesti – Izvoare, Cheia.

10. *Peronospora manshurica* (Naum.) Syd. sur *Glycine hispida* Maxim.

Reg. Braşov – Feldioasa; reg. Bucuresti.

11. *Peronospora mayori* Gäum. sur *Vicia angustifolia* L. var. *segetalis* (Thuil.) Koch:

Reg. Ploesti – Chitorani, Pucheni; reg. Bucuresti Baneasa, Pasarea, Comana;
Marculesti; reg. Arges – Badulesti, Valea Mare, Dragodana, Mihaesti, Domnesti.

Sur *Vicia cracca* L.

Reg. Iasi – Iaşi, Mirzesti ; reg. Bucuresti – Comana, Mihai Bravul.

Sur *Vicia pannonica* Crantz

Reg. Bucuresti – Oltenita, Ciorogirla; reg. Ploesti – Chitorani; reg. Hunedoara – Orastie.

12. *Peronospora meliloti* Sydow sur *Melilotus albus* Desv.

Reg. Dobrogea – Hagighiol, Babadag.

Sur *Melilotus officinalis* (L.) Lam.

Reg. Iasi – Horpaz, Frasuleni; reg. Bacau – Baltatesti, Cracaoani; reg. Bucuresti – Manastirea,
Lehliu; Marculesti.

13. *Peronospora ononidis* Wilson sur *Ononis hircina* Jacq.

Reg. Arges – dans la vallée de la rivière Topolog, Gura Lotrului.

14. *Peronospora orobi* Gäum. sur *Lathyrus tuberosus* L.

Reg. Iasi – Breazu; reg. Bucuresti – Catelu; reg. Arges – Badulesti, Patroaia.

15. *Peronospora pisi* Sydow sur *Pisum sativum* L.

Reg. Iasi – Copou; reg. Bucuresti – Herastrau, Pantelimon, Chiselet; reg. Arges – Slobozia.

16. *Peronospora pratensis* Sydow sur *Trifolium pratense* L.
Reg. Ploesti - Izvoare; reg. Cluj - Vintu de Jos; reg. Hunedoara - Geoagiu; reg. autonoma maghiara - Tg. Sacuiesc; rey. Suceava - Prisaca.
17. *Peronospora romanica* Savul. et Rayss sur *Medicago falcata* L.
Reg. Iasi - Copou, Valea lui David.

Sur *Medicago falcata*(L.) Doll. var. *romanica* (Prodan) Hayek
Reg. Oltenia - Virciorova.
18. *Peronospora ruegeriae* Gäum. sur *Onobrychis sativa* Lam.
Reg. Bucuresti - Baneasa.
19. *Peronospora senneniana* Fragoso et Sacc. sur *Lathyrus niger* (L.) Berk.
Reg. Ploesti - Chitorani, Plopeni, Gageni; reg. Arges - Mihailesti, Horez; reg. Brasov - Turnu Rosu.
20. *Peronospora sepium* Gäum. sur *Vicia sepium* L.
Reg. Bacau - Calugara, Bacau; reg. Galati - Vidra; reg. Ploesti - Izvoare; reg. Cluj - Capilna.
21. *Peronospora tetragonolobi* Gaum. sur *Tetragonolobus siliquosus* (L.) Roth
Reg. Dobrogea - Periprava, Rosetti, Letea.
22. *Peronospora trifolii-alpestris* Gäum. sur *Trifolium alpestre* L.
Reg. Iasi - Mirzesti, Ruseni, Vladiceni; reg. Suceava - Vatra Dornii; reg. Cluj - Valea Vinului; reg. autonoma maghiara - Gheorghieni, Ghilcos, Lunca de Sus, Bretcu; reg. Braşov - Fagaras, Poiana Sibiu, Jina; reg. Bucuresti - Comana, Mihai Bravu.
23. *Peronospora trifolii-arvensis* Sydow sur *Trifolium arvense* L.
Reg. Iasi - Sorogari, Breazu; reg. Bacau - Piatra Neamt, Dobreni; reg. Ploesti - Izvoare; reg. Brasov - Bran; reg. Cluj - Sugag; reg. Hunedoara - Orastie; reg. Banat- Cladova.
24. *Peronospora trifolii-hybridi* Gaum. sur *Trifolium hybridum* L.
Reg. Ploesti - R. Sarat, Chiojdeni; reg. Bucuresti - Herastrau, Copaceni.

Sur *Trifolium striatum* L.
Reg. Bucuresti - Herastrau.
25. *Peronospora trifolii-minoris* Gäum. sur *Trifolium procumbens* L.
Reg. Iasi - Breazu; reg. Argeş - Mihaesti.

Sur *Trifolium dubium* Sibth.
Reg. Suceava - Cimpulung, Vatra Moldovitei.
26. *Peronospora trifolii-repentis* Sydow sur *Trifolium repens* L.
Reg. Bacau - Cracaoani, Onesti, Borzesti; reg. Ploesti - Carpinistea, Sinaia-Valea Rea; reg. Arges - Cimpulung; reg. Brasov - Timisul de Sus; reg. autonoma maghiara - Gheorghieni, Toplita, Borsec.
27. *Peronospora trigonellae* Gäum. sur *Trigonella* sp.
Reg. Iasi - Valea Lupului.

28. *Peronospora viciae* (Berk.) Gäum. sur *Vicia hirsuta* (L.) Koch
Reg. Iasi – Breazu; reg. Ploesti – Chiojdeni, R. Sarat; reg. Bucuresti – Pasarea.

Sur *Vicia grandiflora* L.

Reg. Ploesti – Buzau; reg. Bucuresti – Herastrau; reg. Hunedoara – Orastie.

Sur *Vicia lathyroides* L.

Reg. Bucuresti – Cernica; reg. Arges – Badulesti, Gura Foii, Curtea de Arges.

Sur *Vicia pisiformis* L.

Reg. Ploesti – Buzau; reg. Bucuresti – Comana.

Sur *Vicia tenuifolia* Roth.

Reg. Dobroga – Macin, Greci.

Sur *Vicia tetrasperma* (L.) Moench

Reg. Iasi – Breazu; reg. Ploesti – Chiojdeni, R. Sarat.

29. *Peronospora viciae-sativae* Gaum. sur *Vicia villosa* Roth

Reg. Ploesti – Chitorani.

Sur *Vicia sativa* L.

Reg. Iasi – Tg. Frumos; reg. Galati – Baleni, Raducesti; reg. Ploesti – Chiojdeni, Gageni; reg. Arges – Minastirea Dealului; reg. Oltenia – Virciorova; reg. Timisoara – Orsova; reg. Hunedoara – Orastie.

Parmi les 29 espèces du genre *Peronospora* parasites sur des plantes de la famille des Légumineuses, quelques espèces présentent un certain degré de polyphagie, comme *Peronospora aestivalis*, *P. mayori*, *P. viciae*, qui sont capables d'infecter plusieurs espèces appartenant à un seul genre, tandis que les autres 26 espèces sont strictement spécialisées.

En ce qui concerne leur aire de distribution géographique dans la République Populaire Roumaine, les espèces *Peronospora aestivalis*, *P. mayori*, *P. pisi*, *P. viciae*, *P. viciae-sativae*, *P. trifolii-arvensis*, *P. trifolii-alpestris*, *P. trifolii-repentis*, sont les plus fréquentes, étant trouvées dans presque toutes les régions de notre pays, en partant de la plaine jusque dans la zone des montagnes, tandis que les autres espèces ont une distribution limitée et même parfois fort restreinte (*P. manshurica*, *P. ononidis*, *P. romanica*, *P. tetragonolobi*).

La répartition sur une aire géographique plus large des espèces citées ci-dessus est due probablement aussi au fait qu'elles sont parasites sur de différentes Légumineuses cultivées, non seulement sur des plantes de la flore spontanée.

Les Péronosporacées décrites dans cette note ont été distribuées pour la plupart dans les fascicules de l'Herbarium mycologicum romanicum (17 espèces) et elles se trouvent dans l'herbier mycologique de la Section de Phytopathologie de l'Institut de Recherches Agronomiques ainsi que dans l'herbier mycologique du Laboratoire de Phytopathologie de la Faculté de Sciences Naturelles de Bucarest.

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DE QUELQUES CHAMPIGNONS SUPERIEURS RECOLTES PAR M. KUC AU SPITSBERG EN 1958

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ABSTRACT

In this contribution to the mycoflora of Spitsbergen notes are given on arctic fungi collected by Dr. M. Kuc. Ten higher fungi were determined of which 2 belong to *Discomycetes*, 7 — to *Agaricales* and 1 to *Gasteromycetes*. Eight species are new records for this country.

A l'occasion de l'Année Géophysique Internationale, une équipe polonaise de savants a travaillé à Hornsund, au Spitsberg (Svalbard). Marian Kuc, bryologue de l'Institut Botanique de l'Académie Polonaise des Sciences, faisait partie de cette équipe pendant l'été 1958. Au cours de ses recherches, il a récolté quelques exemplaires de champignons qu'il a bien voulu mettre à ma disposition, et je saisis l'occasion de l'en remercier ici. Ces champignons ont été introduits dans l'herbier du Laboratoire Mycologique de L'Institut.

La connaissance de la flore des champignons supérieurs du Spitsberg est actuellement très restreinte. Jusqu'à présent, on n'y a noté que la présence de 7 espèces de *Discomycetes*, 34 — d'*Agaricales* et 7 — de *Gasteromycetes*. Ces spécimens ont été récoltés en général au cours de divers travaux et recherches et non par des spécialistes et les renseignements les concernant se trouvent dans les ouvrages de Summerhayes & Elton (1928), Dobbs (1942), Lindblom (1841), Karsten (1872), Eaton (1878), Hagen (1950) et de M. Lange (1955, 1957). En plus, Hagen cite quelques champignons indiqués dans les travaux de Hariot (1893) et de Michelmores (1934), et souligne à cette occasion, que des études mycologiques détaillées faites sur le terrain même des régions arctiques seraient de grand intérêt. On obtiendrait de cette manière de nombreux renseignements intéressants sur la limite septentrionale de l'aire de répartition des champignons en question.

Le matériel récolté par des non-specialists est en général maigre, avec description inexacte, ce que complique énormément sa détermination; il est parfois mal conservé, vu sa consistance charnue, périssable, sans parler des difficultés liées à la conservation et au transport dans de dures conditions du terrain.

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M. Kuc lui non plus n'a pas pu éviter ce genre de difficultés et sur les 12 espèces de champignons supérieurs récoltés par lui, seul 10 espèces ont pu être déterminées, dont 8 ont été pour la première fois signalées au Spitsberg. Vu les maigres données sur la flore mycologique du Spitsberg, j'espère que cette note, ajoutée à d'autre, servira à établir la liste des champignons poussant sur ces îles, tout en fournissant des renseignements sur la répartition géographique de ces champignons.

ASCOMYCETES

Gymnomitrula gracilis (Karst.) Imai = *Mitrula gracilis* Karst. = *Mitrula muscicola* P. Henn. (Figs. 1 et 2).

Entre le glacier Hansa et le mont Rotjesfjellet. Parmi les mousses nitrophiles.

Réceptacles nombreux, isolés ou poussant en groupes, stipités, charnus, haut de 3-5 mm. Tête subglobuleuse ou largement oblongue, arrondie au sommet, glabre,

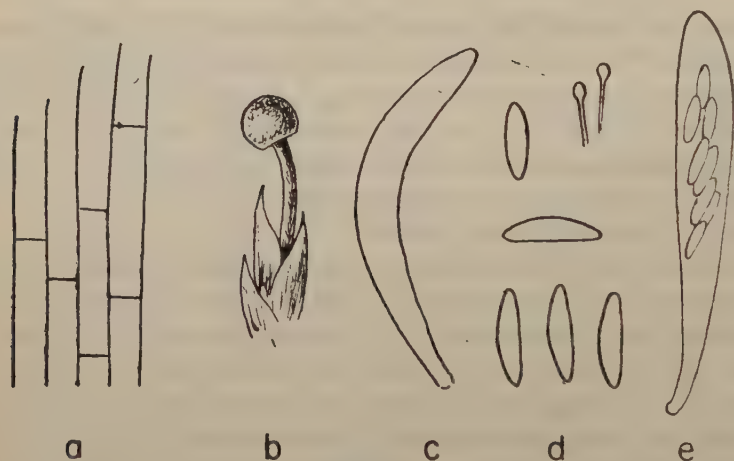


Figure 1

Gymnomitrula gracilis

a) filaments du pied ($\times 830$);

b) réceptacle ($\times 8$);

c) paraphyses ($\times 830$);

d) spores ($\times 1250$);

e) asques ($\times 830$)

large de 0,8 à 1,2 mm et haute de 1 à 1,5 mm, d'un jaune rosé allant au jaune orange et passant par dessiccation à l'orange brunâtre; à sa base séparée du pied par un petit bord nettement libre. Petit pied filiforme, droit, lisse, environ 0,1 mm d'épaisseur, haut de 3-4 mm. Asques 60-80 \times 6 μ , octospores, cylindriques ou faiblement rétrécies vers la base, au sommet arrondi; pores faiblement bleuissant par l'iode. Spores uni- et bisériées, étroitement fusiformes et obtuses aux extrémités, droites ou légèrement courbées, lisses, hyalines, continues, puis septées, 9-10,5-15 \times 3 μ . Paraphyses filiformes, épaissies dans leur partie supérieure jusqu'à 1,5 μ .

Réceptacles se trouvent sur la face extérieure ou intérieure des feuilles de mousse, qui forment tout autour un coussin compact. Ce champignon connu dans divers pays septentrionaux ainsi que dans les Alpes, a été récolté pour la première fois au Spitsberg.

Sclerotinia tuberosa (Hedw.) Fuckel

Sofiekammen, 26.VI.58. Avalanches de pierre que les oiseaux ont couvertes d'excréments; sur les mousses *Syntrichia ruralis* et les autres.

De nombreux auteurs européens et américains mentionnent que ce champignon pousse sur les sclérotés liés aux rhizomes d'*Anemone nemorosa*. Lebedewa (1928)



Figure 2

Coupe dans la tête de *Gymnomitrula gracilis* ($\times 57$)

en a trouvé un spécimen dans la toundra sibérienne. Les exemplaires rencontrés pour la première fois au Spitsberg sortaient d'un sclérote profondément enfoncé, de même que ceux qui ont été récoltés en Sibérie dans un épais tapis de mousse.

BASIDIOMYCETES

Calvatia tatrensis Holl.

Ariekammen, 2.VII.58. Versant occidental couvert de mousses.

Un spécimen merveilleusement conservé, avec spores ornées de verrues très fines, correspond parfaitement à la description de *Calvatia tatrensis* Holl. (Smarda 1958; Ecblad 1955, fig.3b). C'est pour la première fois que cette espèce arctique-alpine a été récoltée au Spitsberg. Hagen (l.c.) mentionne de ces îles une espèce apparentée et avance aussi certaines suppositions quant aux autres *Gasteromycetes*, indiqués auparavant de ces endroits sous divers noms: *Lycoperdon giganteum* (Batsch) Pers.; *L. caelatum* Bull. et *Scleroderma aurantiacum* Pers. (Dobbs 1942). Il n'exclut pas la possibilité, que ces espèces, après un nouvel examen, ne révèlent leur appartenance au *Calvatia cretacea*. Mais vu la découverte au Spitsberg de *C. tatrensis* — ils pourraient tout aussi appartenir à cette espèce.

Cortinarius (Myxacium) alpinus Boud. (Fig. 3)

Isbjørhamna: Fuglebergsletta, 17.VII.58. Sur la terre sablonneuse.

Exemplaire jeune, ayant à peine eu le temps de déchirer sa cortine. Chapeau 3 cm, ocre-brun, jaune-brun, avec le sommet d'un châtain plus sombre, visqueux; bord clair, lisse; cuticule séparable. Pied non bulbeux, clair, blanchâtre au sommet, avec un épaississement en forme d'anneau et avec un reste de cortine blanche et visqueuse. Lamelles brunes, épaisses, adnées. Chaire du chapeau — ferme, du pied — passant au centre à une consistance spongieuse. Hyphes extérieures à la

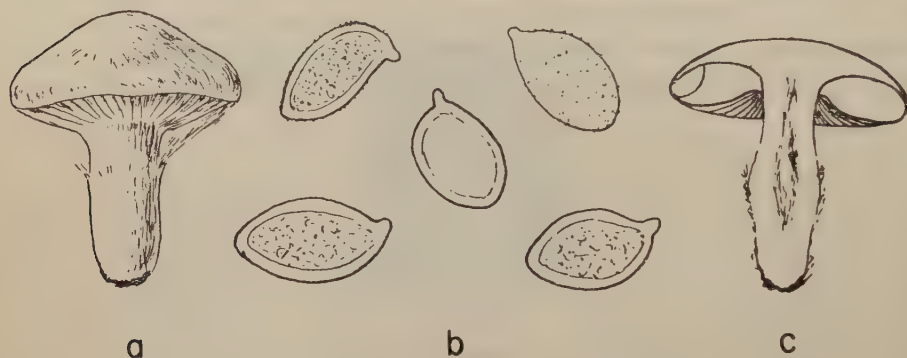


Figure 3

Cortinarius alpinus

a, c) carpophore et sa coupe (1: 1); b) spores ($\times 1250$)

cuticule sont gélatineuses, celles de l'intérieur sont normales, d'un brun clair. Spores jaunes, finement verruqueuses, $6-7,5 \times 13,5-16 \mu$.

Connu dans les Alpes, la Laponie et le Groenland. Au Spitsberg il a été récolté pour la première fois par Hagen (1950) et déterminé par M. Lange (1957).

Hebeloma pusillum J. E. Lange

Flugleberget, 27.VII.58. Sur un tronc pourri, couvert de mousses.

Les deux exemplaires récoltés correspondent bien à la description originale que l'auteur présente en plus du dessin des spores lisses (J.E.Lange 1938). Par contre Favre (1948, fig.51 — aux Alpes) et M.Lange (1957 — au Groenland) ont récolté des spécimens avec des spores "finement verruqueuses". Les champignons récoltés au Spitsberg ont des spores lisses ou au plus légèrement rugueuses; je suppose qu'ils ont été récoltés très jeunes. Ce champignon a été trouvé au Spitsberg pour la première fois. Il a poussé certainement tout à fait par hasard sur un tronc moussu et pourri.

Hygrophorus vitellinus Fr. sensu Moller (Fig.4)

Rotjesllefjet, versant occidental, 11.VII.58. Sur des mousses mortes.
Les jeunes réceptacles récoltés sont d'une grandeur, d'une forme, d'une couleur (Kuc: jaune-citron) et d'une anatomie répondant parfaitement à la description de Moller (1945). Les spores peu nombreuses, déjà formées, 7,5-9 μ . En section seulement on peut observer une certaine différence et notamment le contour des lamelles est bien moins triangulaire que dans les champignons reproduits en couleurs par

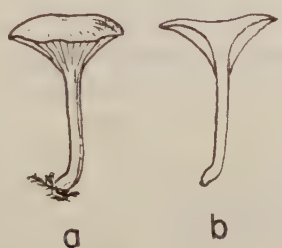


Figure 4
Hygrophorus vitellinus
a) carpophore et sa b) coupe (1: 1)

Moller (l.c., tab.II b), et rappellent plutôt les dessins blanc-noir de cet auteur et de M. Lange (1955). Il se peut aussi que dans ce cas, l'instabilité individuelle et le jeune âge jouent un certain rôle.

Ce champignon commun au Groenland, connu en Island et dans les îles Féroé, a été observé pour la première fois au Spitsberg.

Omphalina ericetorum (Fr.) M. Lange

Hornsund: environ du lac Rervatnet, bord occidental, 21.VII.58. Sur les mousses.
Cette espèce sous le nom d'*Omphalia umbellifera* (L.) Fr. a été plusieurs fois trouvée à Spitsberg aux endroits indiqués dans le tableau qui suit:

Lindblom 1841	Karsten 1872	Dobbs 1942	Hagen 1950
Bruce City	Bruce City	Bruce City	Murchisonfjorden: Randstupe
	Advent Bay?	King's Bay	Magdalenefjorden Kroddfjorden: Kap Mitra Hopen: Thorkelsenskard

Selon Hagen *Omphalia ericetorum* est un des agarics le plus communs dans les régions arctiques.

***Omphalina obscurata* (Kühner) M. Lange = *Omphalia rustica* (Pers.) sensu J.E. Lange**

Skotjesfjellet, 20.VII.58. Parmi les mousses très basses sur un sol sableux.

Seul un réceptacle haut de 0,8 cm., à chapeau large de 0,9 cm. a été récolté. Lange est d'avis que cette espèce est un des éléments les plus typiques de la flore arctique-alpine (M.Lange 1950). Espèce nouvelle pour le Spitsberg.

***Pholiota pumila* Fr. (Fig.5)**

Ariekammen, versant occidental, environ 400 m au dessus du niveau de la mer, 29.VI.58. Sur les mousses.

Le matériel du Spitsberg renferme quelques exemplaires plus ou moins jeunes de champignons qui ont poussé en troupes ou isolement, plus rarement en touffes,

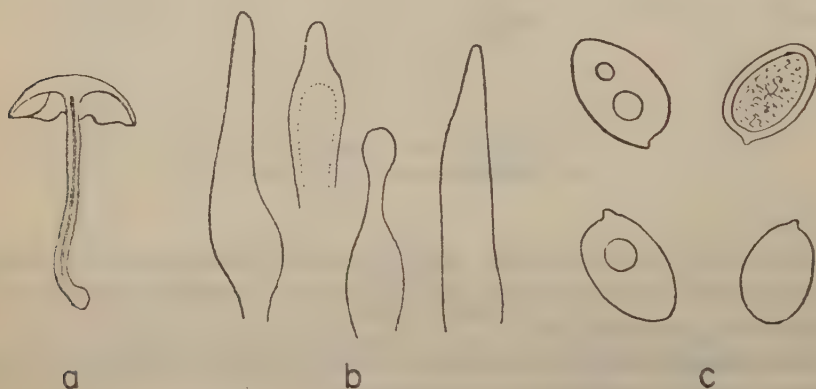


Figure 5

Pholiota pumila

a) coupe dans le carpophore (1:1); b) cystides ($\times 750$) c) spores ($\times 1250$)

liant assez fortement les mousses par leur mycélium. Ces exemplaires sont proportionnellement assez fins. Les champignons de cette espèce se rencontrent au Danemark, en Grande Bretagne et en Norvège; dans les îles Féroé ils poussaient sur des cousins de mousse; Moller (1945) en parle en les nommant "les spécifiques de Féroé". Les spécimens récoltés pour la première fois au Spitsberg, poussent aussi sur des mousses des genres *Calliergon* et *Camptothecium*.

***Rhodophyllus rhodocylix* (Lasch.) J.E.Lange (Fig.6)**

Hornsund, Station de l'Expédition Polonaise. Dans une caisse de plantes gardées dans une maison. Les exemplaires récoltés par M.Kuc répondent aux descriptions et aux planches en couleurs de J.E.Lange (1936), Romagnesi (1932) et Kühner & Romagnesi (1953). Seule la couleur du champignon, définie par Kuc comme brune, n'est pas exacte

et peut éveiller certains doutes; d'autre part, Romagnesi dit que la teinte peut être "brunâtre".

Cette espèce a été trouvée au Spitsberg pour la première fois.



Figure 6

Rhodophyllus rhodocylix
spores ($\times 1000$)

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INOCULATION EXPERIMENTS WITH THE STEM RUST *PUCCINIA GRAMINIS* IN BOHEMIA (CZECHOSLOVAKIA)

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ABSTRACT

In the spring and early summer of 1959, infection experiments were made in Central and Southern Bohemia for the purpose of ascertaining which physiological forms of *Puccinia graminis* were present. In each experiment, 9 standard differential grasses were inoculated with aeciospores from *Berberis vulgaris* and the inoculum from Central Bohemia was found to be unable to infect the standard differential grasses. It is highly probable that the fungi mostly present are in fact unrecognized graminicolous physiological forms of stem rust. In Southern Bohemia two graminicolous physiological forms were identified, i.e. f. sp. *dactylidis* and f. sp. *agrostidis*, and in both cases inoculation experiments failed with the cereals used in the experiments although both wheat (Central Bohemia) and rye are cultivated in these regions. The physiological form on *Dactylis* belongs to *Puccinia graminis* subsp. *media* var. *erikssonii* whilst it is probable that the form on *Agrostis* approaches subsp. *minor*.

INTRODUCTION

The cereal rusts are of great economic importance in Europe as well as in other parts of the world. For this reason, one of the six accepted resolutions of the 4th International Phytopathological Congress in Hamburg (1957) was dedicated to the European rust problem. Subsequently, an international symposium on stem rust was held in Versailles (1958), and, from the contributions to the symposium, it was evident that the economic importance of stem rust called for further investigations and more international co-operation.

Puccinia graminis is not unimportant in Bohemia, too, (cf. Urban 1954) but stem rust has been little studied in this country. The present paper is, therefore, an initial step towards our knowledge of this rust conforming with the all-European co-operation for the study of stem rust.

MATERIALS AND METHODS

Locality and source. There are two localities in Bohemia where *Berberis vulgaris* L. is relatively rather abundant and it is from here that the inoculum (aeciospores) was gathered:

Císarská rokle near Srbsko, Beroun district, Central Bohemia, 13th May, 1959, 300–360 m, facing southeast to east.

Received May 18, 1960.

1. Transitory communities of the alliance *Festucion vallesiaceae* Klika, characterized by bushy shrubs of *Cerasus fruticosa* (Pall.) Woron., *Prunus spinosa* L. and *Berberis vulgaris* L.

2. A 1m tall, non-flowering barberry which was sampled at a height of 20–30 cm above ground level.

3. As above.

4. As above but with *Bothriochloa ischaemum* (L.) Keng. adjacent.

NOTE: Grouped aecia were present on individual spots at different stages of development but only those leaves bearing a number of unopened aecia (resembling small, closed tubes) were collected. Most of the barberries were in flower but the margins of the petals had begun to bleach. The young shrubs were the most severely infected.

Výšenské kopce, Český Krumlov district, Southern Bohemia, 27th May, 1959, 560m, facing northwest.

5. An old, weakly infected shrub on the roadside beneath which were found the dead, previous years' culms of *Dactylis glomerata* bearing the telia of *Puccinia graminis*.

6. A bushy stand of *Corylus avellana* and *Betula verrucosa* Ehrh. with infected barberries in small clearings. *Brachypodium pinnatum* (L.) P. Beauv. occurs under the barberry bushes and in their vicinity.

7. Another, similar clearing with infected barberries exposed to western and northwestern winds.

NOTE: Most of the aecia resemble closed, small tubes although some were opened.

Preparation of the inoculum. Leaves bearing aecia were taken to the greenhouse and immediately (4p.m. on the 13th May and 10 a.m. on the 28th May) placed on wet filter paper in Petri dishes. Inoculations were carried out on the 16th and 18th May (cereals) and on the 1st June. On each occasion the aecia were open with their surroundings yellowish from expelled aeciospores.

Inoculation. For inoculation, the tip of the needle was wrapped in a layer of cotton wool with an aqueous agar solution, and was used for transferring aeciospores. In each pot about ten seedlings were inoculated.

Infected standard grasses. For both experiments, the standard grasses were sown at approximately weekly intervals, i.e. on the 29th April and 6th May (cereals) and also on the 15th and the 23rd May (cereals).

The following standard differential grasses, originating from the Ecole nationale d'agriculture de Grignon, were inoculated.

Agrostis canina L.

Arrhenatherum elatius (L.) Presl

Avena sativa L. cv. *Argentine*

Dactylis glomerata L. cv. *trifolium II*

Lolium perenne L. cv. *otofte Dux III*

Phleum pratense L. cv. *otofte A III*

Poa nemoralis L.

Secale cereale L. cv. *Petkuser Roggen*

Triticum aestivum L. em. Fiori et Paoletti

var. *erythroleucon* (Körn.) Mansf. cv. *mentana* (original of Rome).

Inoculating conditions. After watering, the plants were inoculated and placed for about 24 hours, under a glass trap, the inner surface of which was covered with a film of moisture. The temperature during this period varied from 18° to 22°C.

TABLE I

The reaction of standard differential grass seedlings to inoculation with aeciospores of Puccinia graminis collected in Central and Southern Bohemia in 1959

Standard differential grasses	NoI. of inoculum						<i>Dactylis 5</i>
	2	3	4	5	6	7	
<i>Agrostis canina</i>	i	i	i	I-II**	III***	i	i
<i>Arrhenatherum elatius</i>	i	i	i	i	i	i	—
<i>Avena sativa</i>	i	i	i	i	i	i	—
<i>Triticum aestivum</i>	i	i	i	i	i	i	—
<i>Dactylis glomerata</i>	i	i	i	IV****	I 20*	i	III-IV 8*
<i>Lolium perenne</i>	i	i	i	i	i	i	—
<i>Phleum pratense</i>	i	i	i	i	i	i	—
<i>Poa nemoralis</i>	i	i	i	i	I***** 16*	i	—
<i>Secale cereale</i>	i	i	i	i	i	i	—

Types of infection: i — immune; O — necrotic or chlorotic circles without pustules; I — uredia minute, surrounded by sharp, continuous, chlorotic areas; II — as above but uredia small, surrounded by less clearly defined chlorotic areas; III — uredia small to medium, oval; chlorotic areas hardly perceptible or entirely absent; IV — uredia very large, elongated and without chlorotic areas.

* The first uredia occurred within 14 days after infection unless another interval is noted.

** Besides one leaf with four sori only one uredium on the leaf-blade was found.

*** Many leaf-blades with uredia punctate to short-lined.

**** Heavily infected. Uredia punctate to short-lined in groups up to 2 cm of length. Some coalescent uredia up to 2 cm of length.

***** Uredia punctate surrounded by a large chlorotic area. Only one uredium on a leaf-blade.

RESULTS AND DISCUSSION

The investigations cannot be regarded as complete due to absence of secondary inoculations of the grasses. However, we consider it possible to draw the following conclusions.

In the past, the existence of the following physiological forms within the morphological species *Puccinia graminis* in Europe has been demonstrated:

- P. graminis* f. *agropyri* Mehta et Prasada, Indian J. Agric. Sci. 17:137-151. 1948.*
 f.sp. *agrostidis* Eriksson, Ber. dtsh. bot. Ges. 12: 298. 1894.
 f.sp. *airae* Erikss. et Henn., Z. Pfl.-krankh. 4: 71. 1894
 f.sp. *aperae* Jaczewski, ibid. 20: 353. 1910.
 f.sp. *arrhenatheri* Jaczewski, ibid. 20: 353. 1910.
 f.sp. *avenae* Erikss. et Henn., ibid. 4: 71. 1894.
 f.sp. *calamagrostidis* Jaczewski, ibid. 20: 353. 1910.
 f.sp. *dactylidis* Guyot et Massenot, Ann. Epiphyt. 8: 297. 1957.
 f.sp. *epigei* Eriksson, Cbl. Bakter. 2. Abt., 48: 368. 1918.
 f.sp. *holci* Eriksson, ibid. 48: 364. 1918.
 f.sp. *festucae* Eriksson, ibid. 48: 364. 1918.
 f.sp. *hierochloae* Eriksson, ibid. 48: 364. 1918.
 f.sp. *lolii* Guyot, Massenot et Saccas, Ann. Ecole agric. Grignon, Ser. 3,5: 125. 1946.
 f.sp. *oryzae* Fragoso, Trab. Mus. nac. Cienc. nat. Ser. bot. 15: 39. 1918
 f.sp. *phlei-pratensis* (Erikss. et Henn.) Stakm. et Piem., J. agric. Res. 10: 429-495. 1917.
 f.sp. *poae* Erikss. et Henn., Z. Pfl.-krankh. 4: 71. 1894.
 f.sp. *secalis* Erikss. et Henn., ibid. 4: 71. 1894.
 f.sp. *tritici* Erikss. et Henn., ibid. 4: 71. 1894.

The diagnosis of each physiological form includes a definite host range. However, the affinity of the physiological forms to the individual host is not constant what is expressed by the variability in the type and degree of infection produced by the parasite on the plant. The older authors were also aware, although not so definitely, that a given host range is not constant for an individual physiological form.

Later investigations on the heterothallism of the rusts suggested the possibility of physiological forms hybridizing whilst passing through the barberries. However, little attention has been paid so far to this possibility which was previously discussed by the author (Urban 1945). The theory remains unchanged except for minor details. It is highly probable that the physiological form in nature is a product of environmental conditions and the host range of each form primarily comprises those grasses which are predominant in the neighbourhood of the barberry bushes. Over the years, repeated host combination has given rise to a definite genetical stability. It also seems that the physiological differences are sometimes correlated with morphological characters, e.g. f.sp. *agrostidis* and f.sp. *poae* are characterized by conspicuously small spores (see the tables by Waterhouse 1951 and Batts 1951). Using biometrical measurements, Guyot, Massenot and Saccas (1946) have attempted to classify the European Stem Rust into subspecies and varieties which, of course, also embrace the many different physiological forms. Whilst accepting the principle of this classification we do not consider it to be sufficiently accurate to be applied for the forms existing in nature. In fact, the physiological forms are really to be recognized according to their existence in space and time. Therefore it is not possible to find two absolutely identical physiological forms with the same host ranges in different localities.

* This physiological form is mentioned by Guyot and Massenot (1952), who so identified (p.357) material from *Agropyrum* spp. In India, this form gives negative results on *Berberis vulgaris* but, contrary to the French results, successfully infects *Bromus patulus*. In a later paragraph (p.377), the French authors mentioned a physiological form (on *Agropyrum* spp. in France) as f. sp. *agropyri* (without the author's name) which is unable to infect cereals but gives positive results on *Berberis vulgaris*. However, it is hard to say which form the French authors meant.

Looking at our investigations from this point of view, it seems highly probable, that there occur in Císar'ská rokle previously unrecognized graminicolous forms whose hosts have not been used in experiments, e.g. *Brachypodium pinnatum*, *Phleum phleoides*, *Agropyrum intermedium*, *Bromus erectus*, *Festuca sulcata*, *F. vallesiaca*, *F. duriuscula*, *Melica ciliata*, *Koeleria gracilis*.

In the previous paper (Urban 1954), the author considered that he had found in Výchenskè kopce mostly graminicolous forms of stem rust which reflected the influence of the environment (haplont in close proximity to diplont) on their development, and this opinion has now been confirmed. Before forming definite conclusions on the physiological forms, a statistical analysis of spore measurements was made: (Table II).

The experimental results from locality 5 indicate that f. sp. *dactylidis* was dominant (judging from the secondary positive infections with *Dactylis glomerata* whilst *Agrostis* remained uninfected). It is, however, highly probable that a mixture of the physiological forms was used and, according to the urediospore measurements, the form which developed on *Agrostis* belonged to f. sp. *agrostidis*.

Similarly, a mixture of physiological forms was collected from locality 6. In this experiment, whilst f. sp. *agrostidis* prevailed, a rust developed on *Dactylis* but no definite conclusions could be reached about the identity of the infection as it was slight and late in developing.

TABLE III

Urediospore measurements from material collected in Bohemia compared with those from Germany, France, Scotland and the U.S.A.

Forma specialis	Length μ		Width μ		Authority
	Range	M	Range	M	
<i>dactylidis</i>	18.45—29.52	23.83	13.53—22.14	17.34	C. Krumlov 5
<i>dactylidis</i>	19.68—29.52	24.69	13.53—23.37	17.94	C. Krumlov 5 second.
<i>dactylidis</i>	20 — 33	24.93	14 — 19	16.46	Guyot, Massenot et Saccas 1946
<i>Dactylis</i>	—	22.46	—	16.93	Straib 1952
<i>agrostidis</i>	14.76—22.14	18.45	12.30—18.56	15.20	C. Krumlov 5
<i>agrostidis</i>	14.76—27.06	20.36	12.30—22.14	16.21	C. Krumlov 6
<i>agrostidis</i>	14.76—23.37	18.46	9.84—18.45	14.76	C. Krumlov 6 (<i>Poa</i>)
<i>agrostidis</i>	—	24.76	—	14.18	Batts 1951
<i>agrostidis</i>	15 — 30	22.37	13 — 18	15.68	Levine 1923

The physiological form, f. sp. *dactylidis*, was described from material collected in the Alps (Basses-Alpes) and Pyrenees (Pyrenées-Orientales) at 1250–1600 m, and, according to the original description, developed aecia rather late in the summer (from the 2nd August) with the teliospores immediately following the urediospores. In their experiments, the French authors were unable to infect cereals, whilst only slight susceptibility of *Arrhenatherum*, *Poa* and *Lolium* was observed. Those grasses found to be naturally infected were *Calamagrostis epigeios*, *Dactylis glomerata* and *Festuca heterophylla*. (cf. Guyot, Malençon and Massenot 1958).

TABLE II
Spore measurements of physiological forms from Southern Bohemia

Loca- lity	Host	Urediospores				Teliospores				Forma specialis	Subspecies, varietas
		Range μ	$M_L \pm$ Standard deviation	$M_w \pm$ Standard deviation	L — W	Range μ	M	L — W			
5	<i>Dactylis</i>	18.45–29.52 \times 13.53–22.14	23.83 \pm 2.42	17.34 \pm 1.77	1.37				<i>dactylidis</i>	ssp. <i>media</i> var. <i>erikssonii</i>	
	<i>Dactylis</i> second.	19.68–29.52 \times 13.53–23.37	24.69 \pm 2.33	17.97 \pm 2.33	1.37				<i>dactylidis</i>	ssp. <i>media</i> var. <i>erikssonii</i>	
	<i>Agrostis</i>	14.76–22.14 \times 12.30–18.45	18.45 \pm 1.59	15.20 \pm 1.41	1.21				<i>agrostidis</i>	ssp. <i>minor</i> (?)	
6	<i>Dactylis</i>	14.76–27.06 \times 9.84–17.22	21.25 \pm 2.02	13.54 \pm 1.38	1.56				?		
	<i>Agrostis</i>	14.76–27.06 \times 12.30–22.14	20.36 \pm 2.91	16.21 \pm 2.06	1.25	24.6–41.82 \times 14.76–24.6	33.43 \times 18.91	1.76	<i>agrostidis</i>	ssp. <i>minor</i> (?)	
	<i>Poa</i>	14.76–23.37 \times 9.84–18.45	18.46 \pm 2.10	14.76 \pm 1.48	1.25				<i>agrostidis</i>	ssp. <i>minor</i> (?)	

It is suggested that a similar physiological form occurs in the highlands as well as in the mountains*. However, the life cycle will vary according to the different climatic and other environmental conditions.

The physiological form on *Dactylis*, according to the classification of the French authors, belongs to *Puccinia graminis* ssp. *media* var. *erikssonii*, whereas it is probable that the material on *Agrostis* is close to ssp. *minor* Guyot, Massenot et Saccas. The urediospore measurements for *Agrostis* are considerably smaller and the mean dimensions are just beneath the lower limit for the mean figures given for the variety by the French authors. Thus it is probable that this material is identical to the subspecies *minor*.

CONCLUSIONS

The results confirm the opinion discussed in the previous paper (Urban 1954) that in nature a physiological form is a product of the definite historical and actual conditions relating to a particular place. Hence it is not possible to find exactly the same physiological forms in two different localities. In all series of experiments the forms were unable to infect cereals. Therefore, it is highly probable that in 1959 graminicolous forms prevailed in both localities, i.e. Císarská rokle and Výšenské kopce, which could not infect the cultivated cereals in the neighbourhood. This conclusion is of considerable economic importance and directly affects the methods for controlling stem rust which are to be elaborated after the biology of stem rust in Bohemia (and other parts of Czechoslovakia) has been more thoroughly investigated.

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* Guyot (1944) was unable to infect the cereals-oats, wheat, barley and rye—with urediospores from *Dactylis glomerata* (Department Seine-et-Oise). According to biometrical criteria, it is highly probable that the f.sp. *dactylidis* was present here (urediospores $22-28 \times 15-17\mu$; $M = 24.9 \times 15.7\mu$; $L/W = 1.7$). Recently, the f.sp. *dactylidis* was also collected in Burgundy (Bull. europ. 1959). However, cocksfoot is also a host for f.sp. *avenae* but the urediospore dimensions (on *Dactylis*) are significantly different ($26.2-28.8 \times 16.1-18.1\mu$; $M = 27.4 \times 17.5\mu$; Guyot, Massenot and Saccas 1948a, b).

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INFECTION TRIALS ON GRASSES WITH AN ISOLATE OF *PUCCINIA TRITICINA* RACE 4

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ABSTRACT

The results of an inoculation of several grasses at the seedling stage with an uredosporic isolate of *P. triticina*, race 4, carried out in the greenhouse, are presented. The host range of this strain of *P. triticina* was even smaller than that of *P. graminis tritici*. With a few exceptions, plants that become infected appertained to tribe Hordeae. Certain results suggest that some different records by other authors may be attributed, not only to differences in the aggressivity of the samples of *P. triticina*, but also to ecotypic differences in the plants tested.

INTRODUCTION

There are numerous papers with recorded data of wild and cultivated grasses attacked by *Puccinia* spp. identifiable as *P. rubigo-vera* sensu lato. Nevertheless the data based on the simple morphological study of material do not permit the identification of the infraspecific entities which compose the *rubigo-vera* complex and the true host range of each of them. That is why experimental methods are necessary (Mains 1932).

Very similar host spectra may belong to different rusts of this complex, having their sporophyte harboured by species of *Triticum*, *Aegilops*, *Hordeum*, *Agropyrum*, etc., and a gametophytic host belonging to genera of Ranunculaceae as *Clematis* (*P. agropyri* group), or *Thalictrum* and *Isopyrum* (*P. triticina* group), and even to Boraginaceae (*P. rubigo-vera* s. stricto group; Gäumann 1959). The genus *Triticum*, for instance, may be infected by rusts belonging to any one of these groups (Sibilia 1955, Oliveira 1940).

On the other hand, every group of rusts of the *rubigo-vera* complex, characterised by a common aecidial host, is composed of several closely related taxonomic entities that may hybridize and, according to the authors, are considered as different species or as *formae speciales* of a single species. On the base of hybridization experiments carried out by Shifman (1958) *P. triticina*, *P. agropyrina* and *P. alternans* are considered as "f. speciales" of *P. persistens*.

On account of the complexity of the question, and in view of several contradictory data recorded in the literature, an attempt was made to establish the host range of the sporophytic stage of a genotypic homogeneous inoculum of *P. triticina*.

A knowledge of the behaviour of wild grasses to *P. triticina* has, not only a scientific interest, but a practical one too. In our country, as well as in the Mediterranean

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region in general, the practical significance of the gametophytic host of this as well as the other cereal rusts is secondary and, on the other side, spontaneous wheat and wild grasses represent the most important source of viable inoculum after harvesting.

MATERIAL AND METHODS

The uredosporic inoculum was started by a monosporic isolate, obtained from a sample of rusted wheat collected in the province of Almeria (S. E. of Spain). This isolate when tested against the standard set of differential varieties, behaved as a typical sample of race 4.

The provenance of the seed of the grasses tested is indicated as follows:

(1) Jardin Botanico de Madrid; (2) Jefet Agronómica de Cuenca; (3) Ist. Bot. Univ. Firenze; (4) Inst. Bot. Univ. Liege; (5) Hort. B. Univ. Turkuensis (Finland); (6) R. Bot. Gard. Kew; (7) Hort. Bot. Hauniensis (Copenhagen); (8) Nat. Bot. Gard. Dublin; (9) Bot. Gart. Basel; (10) Arb. Landbouwhogeschool Wageningen.

Seedlings growing in 4 inch pots were inoculated ordinarily at the first leaf stage, except those having very small seed which were inoculated after the plants had several leaves developed. After being kept for 48 hours in a moist chamber, the inoculated plants remained in a greenhouse free from other rusts.

RESULTS AND DISCUSSION

The results recorded on table I show the strong specialization of this uredosporic strain of *P. triticina*, even stronger than that of *P. graminis tritici* (Guyot 1958; Urries 1952).

Aegilops spp. behaved normally as susceptible, with the exception of *A. bicornis*. This species was also immune in France (Guyot and Massenot 1953). *A. triuncialis* was also susceptible in our trials; similar results were recorded in the United States (Fischer and Levine 1941) and in India (Vasudeva, Joshi and Lele 1954); in France, on the contrary, this species did not become infected in the experiment carried out by Guyot and Massenot (1953). The records in the literature concerning *A. ovata* are contradictory (Guyot, Massenot et Saccas 1946; Dupias 1952); these different results may be based partly on differences in the aggressivity of the rust sample tested by different investigators, but there are also genotypic differences in the seed depending on its provenance. In our trials, plants of *A. ovata* from Malaga were more susceptible than those from Cuenca.

From all the inoculated plants of *Elymus* spp., more or less numerous uredospores were obtained, and those of *E. dasystachys* and *E. excelsus* behaved as susceptible. On the contrary, attempts to infect *Elymus* spp. with this rust failed in France (Guyot) and Japan (Hiratsuka and Miyashita 1954).

Immunity, or smaller or greater resistance, was exhibited by every *Hordeum* species tested, and similar results were obtained in some other countries. It should be remarked that *H. murinum* and *H. marinum* in Australia (Waterhouse 1929), and *H. murinum* in Argentina (Vallega 1947) are susceptible to *P. triticina*.

Agropyrum spp. tested in Japan (Hiratsuka) were resistant and immunity was recorded also for *A. cristatum* and *A. caninum* in North America (Fischer and Levine 1941). Our trials gave results in discordance with these previous records: *A. cristatum* was susceptible, and *A. caninum* behaved somewhat differently depending on the provenance of the seed*.

Bromus spp. reacted to *P. triticina* with less susceptibility than to *P. graminis tritici* (Urries 1952) and only in few instances a small quantity of spores was produced. It is opportune to remark that *B. erectus* appears among the species immune in our trials. This species, on the other hand is the specific host of another rust of the *rubigo-vera* group described by Gäumann (1936) as *P. alternans* f. sp. *bromi-erecti*.

Pustules were formed on plants belonging to *Anthoxanthum*, *Lagurus*, and *Lamarckia*, but in every case the spore production was meager and in consequence we must assume that under natural conditions these grasses do not play any role as hosts of *P. triticina*.

TABLE I

Reaction of grasses inoculated with isolate No. 983 of *P. triticina* (Race 4)

<i>Aegilops bicornis</i> (Forsk.) Jaub. et Spach (3)	0;
<i>Aegilops crassa</i> Boiss. (3)	4
<i>Aegilops ovata</i> L. (2)	1
<i>Aegilops ovata</i> L. (Malaga)	2+
<i>Aegilops squarrosa</i> L. (2)	4—
<i>Aegilops triaristata</i> Willd. (2)	3
<i>Aegilops triuncialis</i> L. (2)	3+
<i>Aegilops ventricosa</i> Tausch (2)	4—
<i>Agropyrum caninum</i> (L.) P. Beauv. (4)	0;
<i>Agropyrum caninum</i> (L.) P. Beauv. (5)	3
<i>Agropyrum cristatum</i> (L.) Baertn. (2)	3
<i>Agropyrum sibiricum</i> P. Beauv. (6)	0;
<i>Agropyrum strictum</i> Reich. (1)	1+
<i>Agropyrum violaceum</i> Vasey (1)	0;
<i>Agrostis alpina</i> Scop. (1)	0
<i>Agrostis canina</i> L. (1)	0
<i>Agrostis nebulosa</i> Boiss. et Reut. (1)	0
<i>Agrostis pallida</i> DC. (1)	0
<i>Agrostis reuteri</i> Boiss. (1)	0
<i>Alopecurus agrestis</i> L. (1)	0
<i>Alopecurus anthoxanthoides</i> Boiss. (1)	0
<i>Alopecurus pratensis</i> L. (8)	0
<i>Alopecurus pratensis</i> var. <i>aurea</i> hort. (10)	0
<i>Anthoxanthum aristatum</i> Boiss. (1)	0
<i>Anthoxanthum ovatum</i> Lag. (1)	1
<i>Arrhenatherum elatius</i> Mert. et Koch (9)	0;
<i>Arrhenatherum elatius</i> Mert. et Koch (5)	0
<i>Avena alba</i> Vahl (1)	0
<i>Avena bromoides</i> Gouan (1)	0
<i>Avena compressa</i> Heuff. (1)	0

* In previous trials with *P. graminis tritici*, similar differences in behaviour were exhibited by plants of *A. caninum* according to their provenance.

<i>Avena corymbosa</i> Nym. (1)	0;
<i>Avena fatua</i> L. (1)	0;
<i>Avena flexuosa</i> Schrank (1)	0;
<i>Avena purpurea</i> Gueldenst. (1)	0;
<i>Avena sativa</i> L. (1)	0
<i>Avena sterilis</i> L. (1)	0
<i>Bachypodium distachyum</i> (L.) P. Beauv. (1)	0
<i>Brachypodium sylvaticum</i> (Huds.) P. Beauv. (1)	0
<i>Briza maxima</i> L. (1)	0
<i>Bromus adoensis</i> Hochst. (1)	0;
<i>Bromus arduennensis</i> Dum. (1)	0
<i>Bromus brachystachys</i> Hornung (1)	1
<i>Bromus ciliatus</i> L. (1)	0
<i>Bromus diffusus</i> Dum. (1)	0
<i>Bromus erectus</i> Huds. (1)	0
<i>Bromus inermis</i> Leyss. (1)	1
<i>Bromus japonicus</i> Thunb. (1)	0;
<i>Bromus kelmii</i> A. Gray (1)	0
<i>Bromus latiglumis</i> (Shear) Hitchc. (1)	0
<i>Bromus madritensis</i> L. (1)	1+
<i>Bromus preslii</i> Kunth (1)	0;
<i>Bromus rigidus</i> Roth. (1)	0
<i>Bromus secalinus</i> L. (1)	0
<i>Bromus squarrosus</i> L. (1)	0;
<i>Bromus sterilis</i> L. (1)	1
<i>Bromus tectorum</i> L. (Madrid)	1
<i>Bromus vernalis</i> Panc.	0
<i>Dactylis glomerata</i> L. (Madrid)	0
<i>Elymus canadensis</i> L. (1)	1+
<i>Elymus dasystachys</i> Trin. (1)	.. + +
<i>Elymus excelsus</i> Turcz. (1)	3+
<i>Elymus junceus</i> Fisch.	0;
<i>Elymus villosus</i> Muhl. (1)	1—
<i>Elymus virginicus</i> L. (1)	1+
<i>Festuca elatior</i> L. (1)	0
<i>Gaudinia fragilis</i> (L.) P. Beauv. (1)	0
<i>Holcus lanatus</i> L. (1)	0
<i>Holcus mollis</i> L. (1)	0
<i>Hordeum bulbosum</i> L. (1)	1
<i>Hordeum distichum</i> L. (1)	1—
<i>Hordeum hexastichum</i> L. (1)	0;
<i>Hordeum jubatum</i> L. (1)	0
<i>Hordeum marinum</i> Huds. (1)	0
<i>Hordeum murinum</i> L. (1)	0
<i>Hordeum secalinum</i> Schreb. (1)	0
<i>Hordeum trifurcatum</i> Jacq. (1)	0;
<i>Hordeum zeocriton</i> L. (1)	2—
<i>Koeleria cristata</i> Pers. (1)	0;
<i>Lagurus ovatus</i> L. (3)	1—
<i>Lamarckia aurea</i> Moench (1)	1—
<i>Lolium lepturoides</i> Boiss. (1)	0
<i>Lolium multiflorum</i> Lam. (1)	0
<i>Lolium perenne</i> L. (4)	0
<i>Lolium rigidum</i> Gaud. (1)	0;
<i>Lolium temulentum</i> L. (1)	0;
<i>Melica ciliata</i> L. (1)	0
<i>Panicum virgatum</i> L. (1)	0
<i>Poa nevadensis</i> Vasey (1)	0
<i>Poa pratensis</i> L. (1)	0
<i>Polypogon monspeliensis</i> Desf. (1)	0
<i>Stipa barbata</i> Desf. (1)	0;
<i>Stipa lagascea</i> R. et S. (1)	0;
<i>Vulpia myuros</i> Gmel. (1)	0

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REMARQUES SUR LES *UROMYCES* PARASITES DES *MEDICAGO*

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ABSTRACT

The detailed study of *Uromyces* forms parasiting on *Medicago* and having verrucous teliospores has established that there exists an ample variation in the biometric features of the spores according to the host plant. Moreover, a pronounced parasitic specialization leads to the conclusion that this type of *Uromyces* is different from *Uromyces anthyllidis* (Grev.) Schroet, and belongs to *Uromyces magnusii* Kleb.

RESUME

Par l'étude des *Uromyces* à téléospores verruqueuses, parasites des *Medicago*, il est établi qu'il existe une ample variation des caractères biométriques des spores suivant l'époque de prélèvement et la nature de l'hôte. En outre une spécialisation parasitaire certaine conduit à envisager que ce type d'*Uromyces* doit être distingué de *U. anthyllidis* (Grev.) Schroet. et désigné: *Uromyces magnusii* Kleb.

A ce jour, 4 espèces du genre *Uromyces* ont été signalées sur les *Medicago* sauvages ou cultivés. Trois de ces espèces présentent entre elles des affinités morphologiques certaines: *U. anthyllidis* (Grev.) Schroet., *U. magnusii* Kleb., *U. anthyllidis* f. *medicagineus* Trotter. Une espèce: *U. striatus* Schroet., est bien caractérisée par ses téléospores pourvues longitudinalement de replis parallèles ou anastomosés. La détermination précise de l'une ou l'autre des 3 premières espèces (à téléospores verruqueuses) est encore actuellement délicate pour plusieurs raisons:

(1) La preuve d'une spécialisation parasitaire bien délimitée n'a pu encore être largement réalisée. Quelques tentatives de transmission expérimentale ont cependant été accomplies. C'est ainsi que Jordi (1904) a mis en évidence que la forme de l'*Uromyces anthyllidis* existant sur l'*Anthyllis vulneraria* L. n'est pas susceptible d'être hébergée par l'*Anthyllis montana* L. De même Viennot-Bourgin (1939), a montré que le transport d'urédorpores de l'*Uromyces magnusii* prélevées sur le *Medicago maculata* Willd. n'entraîne qu'une très légère infection sur le *Medicago minima* L. et le *M. orbicularis* All. qui sont cependant des hôtes habituels de cet *Uromyces*. Il semble donc, par ces quelques résultats fragmentaires, qu'il existe, au sein des *Uromyces* parasites des *Medicago*, de nombreuses formes spéciales, non encore séparées, inféodées à une espèce de plante-hôte ou à un petit groupe d'espèces.

(2) Pour ces 3 espèces, de même que pour l'*Uromyces striatus*, dans un prélèvement effectué dans le même soro ou tout au moins sur un même fragment de plante-hôte,

il est possible d'observer des variantes morphologiques notables. Celles-ci concernent à la fois la dimension et la conformation des spores. C'est ainsi que l'analyse biométrique des sores de l'*Uromyces striatus* après prélèvement soit sur les tiges, soit sur les folioles de la Luzerne cultivée, nous a procuré les moyennes suivantes:

urédospores sur tiges:	$23,2 \times 16,8 \mu$
urédospores sur folioles:	$20,5 \times 17,3 \mu$
téleutospores sur tiges:	$21,5 \times 16,3 \mu$
téleutospores sur folioles:	$20,2 \times 16,1 \mu$

En ce qui concerne la conformation des spores, celle-ci varie selon l'état de développement du parasite. A partir d'infections expérimentales réalisées à l'aide d'urédospores de l'*Uromyces magnusii* prélevées sur le *Medicago maculata* Willd., ayant obtenu une infection positive sur ce même *Medicago*, nous avons observé d'abord des urédospores à paroi jaune pâle, mesurant en moyenne: $22,0 \times 20,6 \mu$ et que l'on peut considérer comme des urédospores "primaires", puis des urédospores de seconde formation, disposées dans des sores semblables. Ces urédospores à paroi brun-roux vif, souvent accompagnées de téleutospores, mesurent en moyenne: $24,4 \times 22,4 \mu$.

De telles variations apparaissent lors de l'analyse des données biométriques fournies par plusieurs auteurs. Elles sont notées en particulier par T. Rayss (1951) pour un *Uromyces* à téleutospores verruqueuses (désigné *U. anthyllidis* f. *medicagineus* Trotter) observé sur 2 espèces de luzerne: *Medicago blancheana* Boiss. et *M. galilaea* Boiss. en Palestine. Sur le premier support les urédospores mesurent $16-20 \mu$ de diamètre; sur la seconde plante-hôte, on observe des urédospores globuleuses mesurant $20-23 \mu$ en même temps que des urédospores ovoïdes, beaucoup plus grandes: $32-33 \times 17-18 \mu$, la conformation des téleutospores qui accompagnent ces urédospores restant cependant constante sur les 2 plantes-hôtes.

Parmi les caractères morphologiques variables que l'on peut encore envisager en observant la sporée des *Uromyces* parasites des *Medicago*, on doit signaler la couleur et l'épaisseur de la paroi des urédospores et des téleutospores. D'une façon générale, pour les Rouilles des végétaux, l'adaptation au xérophytisme, et aussi sans doute l'influence de la luminosité de l'atmosphère accusent des 2 caractères pour des spores prélevées sur des plantes-hôtes récoltées dans les stations sèches ou semi désertiques. Le *Puccinia graminis* Pers. observé sur les *Lolium*, *Aegilops* et *Agropyrum* dans le Négev en est un bon exemple. Les sores, toujours de grande dimension, précocement nus, contiennent une accumulation de spores d'un noir de poix tandis que dans les régions moyennes de l'Europe, les amas sporifères de cette Rouille, d'un roux-noirâtre obscur, n'acquièrent qu'exceptionnellement une couleur aussi marquée. Dans les stations soumises à de grands écarts climatiques, apparaissent des amphispores telles que celles qui ont été observées pour l'*Uromyces gurkeanus* P. Henn. parasite des *Lotus*. C'est à de semblables variations qu'il convient

d'attribuer les imprécisions qui persistent dans l'identification de l'*Uromyces* vivant aux dépens des feuilles de *Trigonella* (*U. trigonellae* Pass.; *U. trigonellae* Pat.; *U. anthyllidis* f. *trigonellae* Rayss, 1951).

Indépendamment des variations d'ordre morphologique dont nous venons de donner quelques exemples, interviennent également des variations dans le comportement biologique des espèces. Pour certaines, telles que l'*Uromyces striatus* considéré sur ses hôtes habituels (*Lathyrus*, *Medicago*, *Pisum*, *Vicia*), les stades urédospores et téléutospores se succèdent insensiblement en même temps que très rapidement. A partir du moment où les folioles sont porteuses d'un grand nombre de sores, on constate l'existence d'amas urédosporifères, de sores à téléutospores en même temps que de "sores mixtes" contenant à la fois les 2 types de sores. La couleur des pustules qui reste assez uniforme, ne permet pas toujours une distinction approchée du type de sore figuré.

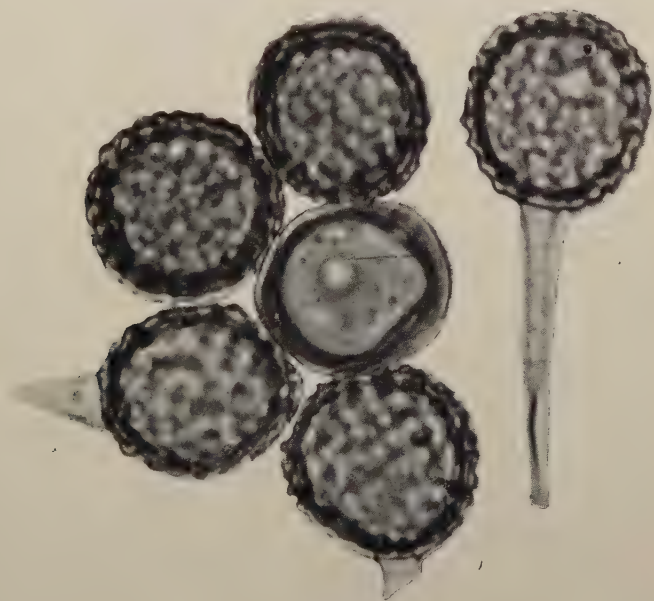


Figure 1

Téléutospores de *Uromyces magnusii* prélevées sur *Medicago sativa*, provenant des environs de Paris, Octobre 1959. (Cliché original P. Bondoux).

Pour l'*Uromyces anthyllidis* (Grev.) Schroet. sur le genre *Anthyllis* en Europe moyenne, le stade urédospore est par contre le plus apparent et le plus durable. C'est ainsi qu'en France sur l'*A. vulneraria*, les récoltes de cette Urédinée ne comportent presque jamais de téléutospores. Les seules mentions d'échantillons présentant les 2 types de spores se rapportent à des localités en altitude: celle de Besse (Puy-de-Dôme, 1933) précisée par T. Rayss, et celle plus récemment mentionnée par Durieu (1954) dans les Pyrénées orientales.

Ce comportement biologique illustré par l'exemple de l'*Uromyces anthyllidis*, est également partagé par l'*Uromyces magnusii* Kleb. qui existe sur un grand nombre de *Medicago* sauvages et en particulier sur le *M. maculata* Willd. et le *M. minima* L. dans presque toute l'Europe et jusqu'aux confins du bassin méditerranéen. Principalement sur le *M. maculata*, depuis 1937, nous constatons (Viennot-Bourgin, 1937) le maintien de l'Urédinée sous forme d'urédospores se renouvelant d'un bout de l'année à l'autre au fur et à mesure qu'apparaissent de nouvelles feuilles. La rouille supporte ainsi les froids des hivers normaux et ne produit qu'exceptionnellement ses téléospores.

Tandis qu'en Europe moyenne, la persistance de l'*Uromyces anthyllidis* et de l'*U. magnusii* peut être considérée comme établie par le moyen des urédospores (à défaut d'une stade écidien expérimentalement prouvé), on constate au contraire pour les *Uromyces* particuliers au bassin méditerranéen une prédominance du stade téléospore par rapport aux urédospores. Le développement de la Rouille se manifeste alors par la formation de sores ordinairement petits, précocement déhiscent, très pulvérulents, de couleur foncée et uniforme. C'est cet aspect que de nombreux auteurs considèrent, avec la verrucosité très apparente de la paroi de la téléospore, comme étant la caractéristique essentielle de l'*Uromyces anthyllidis*. Or il convient de remarquer que:

(1) La couleur prononcée et l'aspect grossièrement verruqueux des téléospores caractérise également, sur de nombreux genres de Légumineuses, des espèces aujourd'hui reconnues comme séparables à la fois de l'*Uromyces anthyllidis* et d'autres espèces d'*Uromyces* vivant sur ces supports.

A titre d'exemple on peut citer:

Uromyces anagyridis (Roussel) Roum. sur *Anagyris*, *U. transcaspicus* Petrak sur *Astragalus*, *U. ciceris-arietini* (Grog.) Jacz. sur *Cicer*, *U. lereddei* Dupias sur *Colutea*, *U. coronillae* Vienn.-Bourg. sur *Coronilla*, *U. hippocrepidis* (Thuem.) Mayor sur *Hippocrepis*, *U. guerkeanus* P. Henn. sur *Lotus*, *U. magnusii* Kleb., *U. heimi* Mayor et Vienn.-Bourg., *U. marinus* Guyot et Malençon sur *Medicago*, etc.

(2) Dans beaucoup de cas ces espèces ont été séparées en tenant compte essentiellement de la nature botanique du support (c'est-à-dire en envisageant la spécialisation parasitaire) et de certains caractères tels que: dimensions relatives des urédospores et des téléospores, nombre de pores germinatifs des urédospores, importance de la papille couvrant le pore germinatif de la téléospore.

En ce qui concerne les 3 espèces à téléospores verruqueuses mentionnées sur les *Medicago* spontanés ou sauvages, la révision de nombreux matériaux d'herbier ainsi que la découverte récente (Viennot-Bourgin et Courtillot, 1960) de l'*Uromyces magnusii* Kleb. en tant que parasite des feuilles et des tiges de *Medicago sativa* (matrix nova) nous permettent d'apporter les remarques suivantes:

(a) Il existe actuellement 5 espèces de *Medicago* susceptibles de porter à la fois un *Uromyces* à téléospores verruqueuses désigné, suivant l'Auteur considéré:

U. magnusii, *U. medicagineus*, *U. anthyllidis*, et un *Uromyces* du type *striatus*. 25 autres espèces de *Medicago* portent soit l'une, soit l'autre des espèces considérées. Ces 5 espèces de plantes-hôtes, ainsi les *Uromyces* qui leur ont été attribués sont les suivants:

	<i>magnusii</i>	<i>Uromyces</i> <i>medicagineus</i>	<i>anthyllidis</i>	<i>striatus</i>
<i>Medicago coronata</i> Desr.		x	x	x
<i>Medicago hispida</i> Gaertn.	x		x	x
<i>Medicago maculata</i> Willd.	x	x		x
<i>Medicago minima</i> L.	x	x	x	x
<i>Medicago orbicularis</i> All.	x		x	x

(b) Le spécimen-type de l'*Uromyces magnusii* Kleb. (1913) existe sur le *Medicago minima*; *Uromyces anthyllidis* subsp. *medicagineus* Trotter (1915) a été décrit sur le *Medicago minima* et le *M. coronata*. Depuis tantôt l'une, tantôt l'autre de ces 2 espèces est signalée sur un deuxième hôte commun: *M. maculata* Willd. (= *M. arabica* All.)

(c) La description originale fournie par Klebahn (in Saccardo, 23,p.653) fait ressortir les affinités morphologiques existant entre l'*Uromyces magnusii* et l'*U. anthyllidis* (Grev). Schroet.

Compte tenu des caractères biologiques de l'*Uromyces anthyllidis* (répartition géographique restreinte, spécialisation parasitaire accusée) ainsi que du comportement en Europe moyenne et en région méditerranéenne de plusieurs espèces d'*Uromyces* antérieurement distingués de l'*U. anthyllidis* sur différents genres de Légumineuses, il nous paraît convenable de considérer que sur le genre *Medicago* existe en fait une seule espèce d'*Uromyces* à téléutospores verruqueuses présentant, comme un grand nombre d'*Uromyces* des Légumineuses, une certaine instabilité dans les caractères morphologiques. Cette espèce doit, par raison de priorité, être désignée *Uromyces magnusii* Kleb. Très répandu dans le bassin méditerranéen sur les *Medicago* spontanés spéciaux à ce domaine, cet *Uromyces* manifeste en Europe une remontée en direction du Nord grâce à 2 plantes-hôtes: *Medicago maculata* et *M. minima*. Tout récemment, dans le bassin parisien ainsi que dans le département de l'Aveyron, le parasitisme de cette espèce s'est étendu à la Luzerne cultivée: *Medicago sativa*.

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A SPECIFIC CASE OF DECREASED RESISTANCE TO STEM RUST RACE 6 IN MATURING OAT PLANTS

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ABSTRACT

A new source of seedling resistance to physiologic race 6 of oat stem rust was discovered in the mutant R22-75-102 originated from Tennessee 1922 × Bond-Iogold. Resistant reactions have been consistently recorded on juvenile plants up to the boot stage. In the heading and ripening stages the phenomenon of "regional resistance" has been observed, i.e. certain plant parts, like the inflorescence, stem portions above the flag leaf and specific sites on sheaths of upper and mid leaves displayed definite susceptibility to stem rust race 6, while leaf blades generally retained resistance in all growth periods throughout April-July.

INTRODUCTION

Prevalence of the extremely virulent and aggressive physiologic race 6 of *Puccinia graminis* Pers f. sp *avenae* Erikss. and Henn., and serious losses caused by recurring oat stem rust outbreaks in Israel stimulated the search for effective sources of resistance to this disease. The main results of our studies are reported elsewhere (Wahl 1958), while the present publication deals with the trials conducted with an oat variety selected by Rosen in Arkansas and designated by him as R22-75-102 (personal communication). This variety referred to hereinafter in this paper as Mutant, is derived from a mutant of Tennessee 1922 × Bond-Iogold (Rosen 1955).

Initially, our interest in the Mutant variety was aroused due to its high resistance to oat stem rust races 6 and 8 in the seedling stage. Subsequently, Mutant was included in varietal field trials in uniform rust observation nurseries located in a dozen or more places, under diverse environmental conditions, in order to ascertain if resistance revealed in seedling stage is retained also when plant development progresses. Anpilogov (1956) and Fedotova (1955) recommend the incorporation in breeding programs of parental material resistant to rusts or other pathogens throughout the entire period of ontogenetic development of the host. Johnston and Melchers (1929), Goulden *et al.* (1930), Simons (1954), and Stakman *et al.* (1953) emphasize the importance of testing of varietal reaction to rusts in adult plants. T. Johnson advises testing plants in adult stage since "...it is necessary before we know definitely how a variety reacts to a race" (personal communication).

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MATERIALS AND METHODS

While investigations carried out by Levine and Smith (1937) were mainly concerned with 2 growth periods, viz. seedling and boot stage, Gassner's studies (Gassner 1932) embraced 10 development grades from very young seedlings to dead-ripe plants ("totreife Pflanzen").

The herein related studies involved 14 development grades, according to the scheme adopted for wheat by Feekes and illustrated by Large (1954). In our case, Feekes' scheme was condensed and modified in conformity with the results of phenologic studies with oat crops conducted by Ephrath (1959). Consequently, rust records were taken in the following growth stages of the Mutant plants:

A. Seedlings

1. First leaf seedlings

B. Tillering

2. Beginning of the erection of the pseudostem, leaf sheaths begin to lengthen.
3. Pseudostems (formed by sheaths of leaves) strongly erected.

C. Stem Extension

4. First node of the stem visible at the base of the shoot.
5. Second node of the stem formed, next-to-last leaf just visible.
6. Last leaf visible, ear beginning to swell.
7. Boot stage.

D. Heading

8. First ear visible.
9. All ears out of sheath.

E. Ripening

10. Milky ripe.
11. Soft dough.
12. Late dough.
13. Full ripe.
14. Dead ripe, ready for harvesting.

For want of controlled-temperature chambers suitable for experimentation with adult plants, the effect of considerable temperature fluctuations throughout April-July was balanced out by repeated sowing at proper time intervals. Thus, plants at different growth stages could be secured for simultaneous inoculations under diverse climatic conditions prevailing in spring and summer. A similar procedure was adopted by Gassner (1932) and Simons (1954). Each series of plants included 3-4 seedlings at the first leaf stage. Details of the planting schedule are given in Table I.

The seedling inoculation technique employed was described by Stakman *et al.* (1944); final readings of the reactions were made 14–17 days after inoculation. Plants selected for inoculation at more advanced age were sown in 12-inch pots, each pot containing 2–4 plants. A set of 3 pots was ordinarily assigned for inoculation at the desired growth period. Inoculations were executed in the following manner: the plant part concerned was debloomed, sufficiently moistened, and gently rubbed with seedling leaves carrying an abundant spore load of stem rust race 6. Subsequently, the inoculated plants were removed to humidity chambers for 24 hours in spring, or 12 hours in summer, and then transferred to the greenhouse and maintained there in isolated compartments until the rust reactions could be determined. Purity of the inoculum could be ascertained by the following procedure: after completion of reaction readings, 3–4 single pustules isolated at random were multiplied separately on Fulghum seedlings and identified eventually on seedlings of the differential varieties: Richland, Minrus (or White Tartar), Jostrain (or Sevnothree). Oat stem rust race 6 was consistently recovered. Whenever reactions of susceptible and resistant class appeared together on the same sheath or other plant part, single pustules representing the diverse reaction classes were isolated and identified on seedlings of differential varieties. The investigated isolates invariably belonged to race 6.

Evaluation of susceptibility and resistance was based on the characteristics of infection types, as described by Stakman *et al.* (1944). Three reaction classes were recognized: very resistant, embracing infection types from 0 to 1+; resistant—signified by infection types ranging from 2– to 3–, inclusive; susceptible reactions comprised infection types varying from 3 to 4+.

RESULTS

Rust reactions on seedlings, juvenile and mature plants

Reactions induced by oat stem rust race 6 on different parts of juvenile plants—prior to boot stage, and on mature plants, are summarized in Table I.

Trials repeatedly performed in April–June proved that first leaf seedlings (Figure 1) and juvenile plants exhibited extreme resistance until the boot stage was reached, while Fulghum seedlings demonstrated under similar conditions complete susceptibility. Reactions became diversified in more advanced growth periods assuming a pattern referred to by Goulden *et al.* (1930) and Welsh (1937) as “regional resistance”. Leaf blades generally retained resistance as the susceptible matured and ripened; mesothetic reactions were very rare and confined to the flag leaf only. In the latter case infection type 3 was manifested on the basal section of the blade—close to the main vein, resistant reactions being located at the middle or at the distal portions of the blade.

In contrast, reactions on the leaf sheaths showed distinct variability. The distribution of infection types formed a regular pattern attesting to the progressing suscep-



Figure 1

Resistance to stem rust race 6 displayed by the first leaf seedlings of the Mutant variety (right). Decrease of resistance on leaf sheaths—severe infection becoming pronounced on the lower section of the internode (left).

tibility towards the base of the sheath (Figure 1). This is evidenced by the data set forth in the last 2 columns of Table I, that indicate the frequency of occurrence of specific rust reactions on the plant parts concerned. For instance, 58 flag leaves produced resistant reactions on the distal sheath portions, while only 9 flag leaves gave rise to susceptible reactions on corresponding sites of the sheath. Conversely, 3 flag leaves supported resistant reactions on the lower sheath sections as contrasted with 106 flag leaves manifesting susceptibility syndrome on similar sheath parts. Parallel shift from resistance to susceptibility in downward direction was ascertained also on sheaths of the second leaf, and to a lesser degree on the sheath of the third leaf (Table I).

TABLE I

Reaction induced by oat stem rust race 6 on different plant parts of the variety Mutant at various stages of host development. Inoculations performed at the indicated dates

April 17			May 11					May 31					June 1						June 18					June 6																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
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1) N - neck, stem section above the flag leaf; F - blade of the flag leaf; Fs - sheath of the flag leaf; Se - blade of the second leaf; Ses - sheath of the second leaf; T - blade of the third leaf; Ts - sheath of the third leaf; Fo - blade of the fourth leaf; Fos - sheath of the fourth leaf; In - inflorescence.

2) R - resistant; VR - very resistant; RU - upper section of the sheath resistant; RM - mid section of the sheath resistant; RL - lower section of the sheath resistant; S - susceptible; SU - upper section of the sheath susceptible; SM - mid section of the sheath susceptible; SL - lower section of the sheath susceptible.

3) Results obtained from inoculation tests performed on June 4th are omitted here for technical reasons; they are similar to those yielded by inoculations carried out on June 1st.

Comparison of reactions on foliage sheaths in different regions of the same plant reveals that resistance becomes enhanced from top to bottom, the lowermost leaves approaching immunity (Table I).

Infected glumes were usually very susceptible to race 6 and the same seemed to be true of the stem neck, the main axis and side branches of the inflorescence. Susceptible reactions could be often observed on the terminal swellings of the peduncles at the point of attachment with the florets.

Rust reactions on late tillers

It has frequently been noted that late tillers emerging while ordinary shoots are either still alive or completely dry, were definitely more susceptible than the ordinary tillers. The shorter the late tillers, the more susceptible were the reactions they displayed. Clear-cut susceptibility could be discerned already in juvenile plants when stem extension commenced and the first node became visible on the culm. Late tillers 20–30 cm long harbored infection types 3 and 3+ not only on inflorescences and leaf sheaths but also on leaf blades of the 3 uppermost leaves. At the same time, blades of the 3 uppermost leaves on ordinary tillers produced resistant reactions when inoculated with uredospores derived from 3 or 3+ type pustules on corresponding blades on late tillers.

Decline of resistance to crown rust in mature Mutant plants was related by Rosen (1955), who attributed these fluctuations in the host — parasite relation to the concurrent rise in temperature in the field. Susceptible reactions in mature plants and in late tillers described here were obviously not incited by temperature increase; they presumably originated due to specific physiologic processes associated with the maturation of the affected parts of the suscept. Fedotova (1958) claims that the increase in leaf rust susceptibility observed in some wheat varieties at the time of heading is correlated with the concurrent drop in the K- and gain in the N content in the foliage.

DISCUSSION AND CONCLUSIONS

It has been frequently demonstrated that reaction of certain varieties of cereal crops to specific rust races is distinctly influenced by the age of the host. It is generally assumed that resistance increases as plants get older. In reality, reactions may shift in either direction in maturing plants (Stakman *et al.* 1953). Campos *et al.* (1953), Joshi and Prasada (1959), and Samborski and Ostapyk (1959) proved that some wheat varieties become susceptible in adult stage to particular rust races.

In oat crops a remarkably good agreement in the response of seedlings and adult plants to stem rust was reported in the U.S. (Levine and Smith 1937, Stakman *et al.* 1923, Stakman and Loegering 1944). Consequently, it was inferred “that the reaction of seedlings to rust forms is a fairly accurate index of the reaction of older plants. . .” (Stakman *et al.* 1923). Contrary to these observations, Gassner

1932) contended that susceptibility progresses with age. Unlike in the case of the U.S. investigators, Gassner's criterion of susceptibility is based on the percentage of rust infection and not on infection type. Welsh (1937) related from Canada that some oat varieties resistant as seedlings to stem rust race 6 produced susceptible reactions on specific parts of an individual maturing plant and resistant ones on other sections of the same host. This heterogenic pattern of reactions formed on a given suscept is referred to as "regional resistance" (Goulden *et al.* 1930).

Our experience gained with the oat variety Mutant conforms to a great extent with Welsh's data. Definite resistance to stem rust race 6 displayed by seedlings declines after the boot stage, as evidenced by appearance of 3 and 3+ type uredinia on sheaths of mid, and upper leaves, on stem neck above the flag leaf and on inflorescence.

There is no correlation between the effect of age of the plant and age of its particular parts in the response to the parasite's attack. While susceptibility tends to develop on the host after the boot stage, older sections of an individual sheath or culm were generally more resistant than the younger portions. Susceptibility of sheaths seemed to drop from top to bottom — the sheath of the flag leaf being the least resistant. These data are essentially in keeping with the results obtained by Johnston and Melchers (1929) who ascertained that in wheat plants possessing adult resistance older leaf parts are less resistant than the younger ones. On the other hand, our data are at variance with Dunin's "theory of immunogenesis" (Gorlenko 1959). Dunin has postulated that in a plant endowed with mature resistance, older parts are more resistant than the younger sections. This could not be confirmed in the case of Mutant.

The herein reported findings, obviously imply that in oats as in other cereals, seedling reactions to rust are not necessarily indicative of the reactions in maturing or ripe plants. Hence, testing plants in more advanced growth periods for disease resistance is very desirable. Breakdown of stem rust resistance in late tillers recorded in Mutant and occurring probably in other cereals does not reflect the rust performance on the investigated variety and may give an exaggerated estimate of the disease damage. Consequently, promising breeding material may be discarded.

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THE GENUS *CROSSOTOLEJEUNEA* FOUND IN AFRICA

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ABSTRACT

The new species *Crossotolejeunea kilimandjarica* S. Arnell is described. It is the first species of the genus observed in Africa.

Crossotolejeunea kilimandjarica S. Arnell sp. nov.

E. Africa, Kilimanjaro. Lower slopes near Kibo Hotel, 1500 m, earth face on shady slope, side of kloof, leg. *E. Esterhuysen* 27263 (type specimen, in Paleobotanical Department, National Museum of Natural History, Stockholm). Ditto, shaded mossy face, *E. Esterhuysen* 27275.

Monoica, parva, pallide virens, muscis consociata, irregulariter pauciramosa. Folia caulina ad approximata, recte patula, subp'ana ad convexa, ovato-triangulara, apice obtusa ad subacuta, margine integro. Lobulus parvus ad magnus, inflatus, carina arcuata. Cellulae marginales $12 \times 20 \mu$, parietibus tenuibus, trigonis nullis. Cellulae mediae $24 \times 24\text{--}30 \mu$, parietibus tenuibus, trigonis nullis vel parvis. Cuticula aspera. Amphigastria parva, cauli aequilata, ad $2/3$ biloba, sinus acutus, lobis subacutis. Perianthia pyriformia, quinqueplicata, plicis longe decurrentibus, omnibus irregulariter papillois. Rostrum breve. Folia floralia perianthio triplo breviora, obovato-oblonga, apice rotundata, lobulo magno. Amphigastrium florale perianthio quadruplo brevius, apice retusum ad breviter bilobum. Androecia parva, sessilia, bracteis 2–3 jugis.

Monoecious, up to 10 mm long, pale green, growing among other bryophytes. Leaves remote to approximate, erectopate, slightly concave, almost triangular, lower margin convex to almost straight, apex subacute to rounded, upper margin strongly arched. Marginal cells about $12 \times 20 \mu$, walls thin, trigones absent. Cells in the middle of the lobe $24 \times 24\text{--}30 \mu$, walls thin, trigones absent or small. Cuticle sparsely and minutely papillose. Lobule small to rather large and inflated, upper margin incurved, no slime papilla observed. Amphigastria small, as broad as or slightly broader than the stem, patent, bilobed to $1/2\text{--}2/3$, lobes broadly lanceolate, subacute, sinus acute. Perianth on long or generally short branches, with one subfloral innovation, obcordate, 5-plicate, plicae verrucose, decurrent to $2/3$ of the length of the perianth. Rostrum short, 30μ long and 34μ broad, built of one row of elongated cells, mouth crenulate. Female bracts short, $1/3\text{--}1/4$ as long as the perianth, apex obtuse to subacute, lobule $2/3$ as long as the lobe, margin entire. Bracteole short, apex retuse to shortly bilobed. Androecia sessile, with 2–3 pairs of bracts.

I think the plant is best placed in the genus *Crossotolejeunea* because of the longly decurrent plicae of the perianth, the short bracts and the subfloral innovation. This is the first species of the genus observed in Africa.

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Figure 1

Crossotolejeunea kilimandjarica S. Arnell.

a. Fragment of shoot in ventral view; b. Leaf; c. Marginal cells from a lobe; d. Small lobule; e. Amphigastria; f. Shoot in side view; g. Perianth in dorsal view; h. Cross section through the middle of perianth; i. Rostrum; j. Female bract.

REVISION OF THE GENUS *HYACINTHELLA* SCHUR

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ABSTRACT

1. The delimitation of *Hyacinthella* from *Bellevalia*, *Muscari* and *Leopoldia* is clarified. The distinctive characters of the genera are listed in Table I.
2. Geographically *Hyacinthella* can be designated as an East-Mediterranean—Sarmatic—Irano-Turanian genus.
3. Chromosome counts are reported for three *Hyacinthella* species and for *Muscari azureum*.
4. The leaf-anatomy of all *Hyacinthella* species was studied especially with regard to their peculiar elevated nerves found in 8 species. The elevated nerves are built of strands of thick-walled fibres situated above the xylem and below the phloem.
5. A key to the species is given.
6. Eleven species comprised in *Hyacinthella* are described and discussed and photographs of the species are provided. Nine species previously referred to this genus are excluded.

The genus *Hyacinthella* (*Liliaceae*), described by Schur in 1856, has been included until recently in *Hyacinthus* (Baker 1871; Ascherson and Graebner 1905–7; Krause in Engler and Prantl 1930) or in *Bellevalia* (Boissier 1884). At present the majority of regional floras follow Salisbury (1866) in subdividing *Hyacinthus* s.l. into several genera (i.e. Hayek 1933; Losina-Losinskaya 1935; Täckholm and Drar 1954; also Chouard 1931) and accept *Hyacinthella* as a genus. However, no revision of the whole genus has so far been published. Chromosome counts of *Hyacinthella* species were also not available.

DELIMITATION OF THE GENUS

The delimitation of the genera *Bellevalia*, *Hyacinthella*, *Muscari* and *Leopoldia* (= *Comus* Salisb.) has been discussed by Feinbrun (1938–40) and will be further clarified in the present paper.

A comparison of the most important diagnostic characters of these genera is given in Table I. It demonstrates that in some diagnostic characters *Hyacinthella* resembles *Bellevalia* (shape of perianth), in others it is more like *Muscari* and *Leopoldia* (seed surface), while in the shape of capsule and in the mode of shedding the perianth it differs from the whole group. The differences between the four genera are much more diverse than usually indicated in literature (e.g. Boissier 1884; Chouard 1931 p.295) and some of the differences cited do not hold in all species.

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TABLE I

Comparison of main characters of Hyacinthella with those of related genera

Characters	<i>Bellevaia</i>	<i>Hyacinthella</i>	<i>Muscari</i>	<i>Leopoldia</i>
1. Capsule	Triquetrous with three prominent ribs	Depressed-globose, valves rounded at back	As in <i>Bellevaia</i>	As in <i>Bellevaia</i>
2. Seed surface	Smooth, black or bluish with a waxy bloom	Reticulate-wrinkled, black, often glossy	As in <i>Hyacinthella</i>	As in <i>Hyacinthella</i>
3. Shape of perianth	Campanulate, tubular, or funnel-shaped, deeply lobed	As in <i>Bellevaia</i>	Urceolate, obovate or subglobose, constricted at apex, with small teeth	Urceolate to cylindrical, constricted at apex, with small teeth
4. Colour of perianth	White, violet or lilac, changing to livid or brown during flowering	Blue or violet, rarely white, not changing to livid or brown	Blue or violet, teeth often white, colour not changing during flowering	Violet greenish, yellow or cream-coloured at base, colour changing during flowering
5. Flower bud	Bearing protuberances in upper part	Protuberances indistinct	No protuberances	As in <i>Bellevaia</i>
6. Perianth	Abscised at base and deciduous after flowering	Splitting or torn longitudinally, remaining attached at base	As in <i>Bellevaia</i>	As in <i>Bellevaia</i>
7. Insertion of filaments	Uniseriate, inserted at base of lobe	Obscurely biseriate, insertion varying	Uniseriate or obscurely biseriate, at the middle of tube	Often biseriate, at the middle of tube
8. No. of leaves	More than 2	2, rarely 1 or 3	Usually more than 2 (rarely 1)	More than 2 (rarely 1)
9. Fibre strands forming elevated nerves	None	Present in the majority of species	None	None

Previous to Feinbrun's paper (1938-40) too much significance had been attributed to the height of the filament insertion when differentiating between *Bellevaia* and *Hyacinthella* (Boissier, Chouard, etc.). However, this character is quite variable in *Hyacinthella* as shown on Figure 1. In *Bellevaia*, on the contrary, filaments are consistently attached at the base of the perianth segments. Characters of high diagnostic value for *Hyacinthella* are listed below.

- (1) Plants small (5-25 cm)
- (2) Leaves 2, rarely 3 or 1, usually with characteristically elevated nerves
- (3) Flowers erect-patent or horizontal, *not nodding*
- (4) Perianth not deciduous
- (5) Capsule depressed-globose, valves rounded at back
- (6) Seeds black, wrinkled.

Apart from these characters the anatomy of the leaves is also quite characteristic in *Hyacinthella*. It will be discussed in detail further on.

Boissier (1884) subdivided the species of his Sect. *Hyacinthella* into two groups: (1) "Folia elevatim multinervia" and (2) "Foliorum nervi non elevati". To the first group belong the species: *H. leucophaea*, *H. pallasiana*, *H. dalmatica*, *H. lineata*, *H. hispida*, *H. heldreichii*, *H. millingenii*, *H. nervosa*. In the second group Boissier included: *Bellevaia micrantha*, *B. azurea*, *B. paradoxa*, *B. persica*.

The species of the first group undoubtedly possess all the characteristic features of *Hyacinthella* and are obviously interrelated. The second group is rather dubious and only two of its four species, *H. micrantha* and *H. persica*, are included for the time being in *Hyacinthella*. The generic affiliation of these species will become clearer when the mode of shedding of their perianth is known and when capsules and seeds are available.

B. azurea (Fenzl) Boiss. or *Hyacinthella azurea* (Fenzl) Chouard is apparently endemic to Asia Minor. To our knowledge it has not been studied after Boissier. Examination of flowering specimens by the present author shows that *H. azurea* differs from *Hyacinthella* in the following characters which are common in *Muscari*: 1) The flowers are nodding during flowering; 2) the number of leaves is 2-5, usually 3, while in *Hyacinthella* it never exceeds 3 and is usually 2; 3) capsule and shedding of perianth are as in *Muscari*. It is therefore proposed to designate it as *Muscari azureum* Fenzl and to include it in Sect. *Pseudomuscari* Los.*

B. paradoxa Boiss. is an Irano-Caucasian species which Losina-Losinskaya placed under *Muscari paradoxum* (F. et M.) Baker in her Sect. *Pseudomuscari* Los.

Losinskaya's Sect. *Pseudomuscari* constitutes a group of problematic species which are difficult to place in any known genus (*Muscari*, *Bellevaia*, *Hyacinthella*) without upsetting the clear notion of these genera. These species have therefore often been moved from one genus to another. The description of Sect. *Pseudomuscari* says: "Perianth not constricted under throat, teeth straight or slightly recurved" (Losina-Losinskaya 1935). By the inclusion of this group in *Muscari*, the main distinctive characteristic of *Muscari* is unnecessarily blurred. It therefore seems that it would be much more profitable to create a new genus for this problematic group, following a thorough comparative study of the principal characters including those of capsule and seed, the latter still unknown in the majority of these species. The study should also comprise the species of Sect. *Oxyodon* Los. now forming part of *Bellevaia*. Geographically the whole group is centred in an area comprising the Caucasus, Armenia, Asia Minor and Iran. Chromosome studies will certainly prove helpful for the elucidation of relationships of this new genus with *Bellevaia*, *Muscari* and *Hyacinthella*.

* Dr. Davis kindly sent me fruiting specimens of *M. azureum*, which clearly show that this species is not a *Hyacinthella*.

It is opportune to remember that while *Bellevallia* has the basic chromosome number $x=4$ and *Leopoldia* $x=9$, and each of the two genera has a characteristic idiogram of its own, the chromosome numbers of *Muscari* are very little known and some are based on questionable identifications. Chromosome numbers were counted by the present author in three *Hyacinthella* species: in *H. heldreichii* and *H. lineata* var. *glabrescens* $2n = 18$ and in *H. nervosa* $2n = 24$. These are the first counts made in *Hyacinthella*.

Bellevallia tristis Bornmueller (1908), referred by Bornmueller to Sect. *Hyacinthella*, is a true *Bellevallia* (compare description of perianth, colour, number of leaves, etc.), and has not been included in the monograph of *Bellevallia* by Feinbrun (1938-40) by mistake.

DISTRIBUTION AND VARIABILITY

Geographically *Hyacinthella* can be designated as an East-Mediterranean—Sarmatic—Irano-Turanian genus. The largest area of distribution is that of Sarmatic *H. leuco-phaea* which is the northernmost species. On the west, *H. dalmatica* marks the westernmost part of the genus' area. Five out of the ten *Hyacinthella* species are found in Asia Minor, and one of them, *H. millingenii*, is also represented in Cyprus. From Asia Minor the range of the genus extends southeast with its steppical representative *H. nervosa*, and further east to N. Persia, with *H. persica*.

Variability of the following characters causes diversification within the genus: hairiness of leaves, presence and amount of fibres next to vascular bundles, posture of leaves, size and colour of perianth, height of stamen insertion, length of flowering pedicels, length and direction of fruiting pedicels.

LEAF ANATOMY IN *Hyacinthella*

The peculiar elevated nerves of the majority of *Hyacinthella* species tempted me to examine cross sections of leaves of all *Hyacinthella* species and of some of the adjoining genera. The study was made from dried specimens. Small leaf pieces were boiled and sectioned and the sections stained in the Réactif Génévois (Congo red and chrysoidin).

The Figures 2-3 (A-K) show cross sections of leaf pieces, comprising one elevated and one non-elevated nerve of the leaf (in some sections the elevated nerve only).

The following tissues can be seen in the cross sections:

- (1) The epidermis layer with a thin cuticle, a thick outer wall (especially in the abaxial epidermis) and thin inner and lateral walls.
- (2) Under the epidermis (both abaxial and adaxial) there are 2-3 layers of thin-walled cells packed with chloroplasts which in the dried specimens appear tangentially flattened. These cells seem to be characteristic of *Hyacinthella* species.
- (3) The innermost part of the mesophyll consists of large thin-walled cells with a thin cytoplasm layer comprising few chloroplasts and a large vacuole. These cells vary in amount in different species. Some of them contain raphide clusters.

(4) The vascular bundle containing elements of phloem and xylem will not be discussed.

(5) At the elevated nerve the vascular bundle is accompanied by two strands of thick-walled fibres, one on the outer side of the phloem, the other, usually larger one, on the outer side of the xylem. The number of fibres in a strand varies in different species. In this regard the strongest fibre strands are found in *H. lineata*. In *H. dalmatica*, which possesses less prominent nerves, the sclerenchymatous strand accompanying the phloem shows in cross section only 3–4 fibres. In *H. nervosa* the number of fibres is also small and in addition the fibres differ from those of other species by a relatively wide diameter and a wide lumen. The fibres in all species except in *H. nervosa* (in which they stain red like cellulosic cell walls) appear yellow in preparations stained with the Réactif Génévois. However, the fibres of all species do not stain purple with fluoroglucin, in contrast to the tracheal elements which turned purple even in dried specimens. In *H. micrantha* and *H. persica*, which have no elevated nerves, no fibre strands are found. The other elements, and especially the tangentially flattened chloroplast-packed cells, appear in the same arrangement as in the main group of *Hyacinthella* species.

In *Muscari azureum* there are no fibre strands, and the subepidermal mesophyll cells are similar to those of *Hyacinthella*. The larger cells with a high water content appear in many layers. This conforms with the fleshy habit of its leaves.

KEY TO THE SPECIES

1. Flowers pedicelled, about 1 cm long, narrow, funnel-shaped. Leaves erect. Filaments very short, inserted at the middle of tube. Plants of southern Russia (Figure 1 C, Plate I 4). *H. pallasiana* (Stev.) A. Los.
— Plants not as above 2
2. Flowers sessile. Perianth 7–9 mm (rarely 6 mm) long, azure-blue. Anthers dark-violet, subexserted. Leaves incurved, wavy, margin ciliolate or scabrous. Plants of steppes and deserts of Palestine, Syria, Mesopotamia and eastern Turkey (Figure 1 G, Plate III 11). *H. nervosa* (Bertol.) Chouard
— Flowers pedicelled, or if sessile, perianth shorter. Plants not as above 3
3. Leaves (sheath and both surfaces of blade) covered with long, strigilous hairs. Leaves and lower part of scape usually bearing red splashes. Second leaf usually much narrower than the first one. Flowering pedicels about half as long as intensely blue flowers. Fruiting pedicels arcuate. Plants of southern Asia Minor, (Figure 1 E, Plate II 7-8). *H. hispida* (J. Gay) Chouard
— Leaves glabrous, or ciliate, or scabrous at margin, and if densely puberulent, the flowers sessile 4

4. Flowers sessile, 2.5–5 mm long, and if 5–6 mm long, flower colour dark blue-violet. 5
- Flowers distinctly pedicelled 7
5. Leaves without prominent nerves, glabrous throughout or densely puberulent underneath; first leaf 3–5 mm broad. Perianth pale blue, 2.5–3 mm long, rarely longer. Filaments shorter than anthers. Plants of Asia Minor (Figure 1 I, Plate IV 13–14). *H. micrantha* (Boiss.) Chouard
- Leaves with distinctly elevated nerves, glabrous throughout or scabrous at margin. Filaments as long as anthers or longer 6
6. Perianth azure-coloured, 3–4 (rarely 5) mm long. Leaves usually very narrow (first leaf 2.5–4 mm broad). Plants of Cyprus and southern Asia Minor (Figure 1 H, Plate IV 12). *H. millingenii* (Post) Feinbr.
- Perianth dark blue-violet, 5–6 mm long. Leaves broader (first leaf 4–10 mm broad). Plants of Asia Minor (Figure 1 F, Plate III 10). *H. heldreichii* (Boiss.) Chouard
- 7 (4). Leaves with long sparse cilia at margin. Plants of Asia Minor (Figure 1 D, Plate II 5–6). *H. lineata* (Steud.) Chouard var. *lineata*
- Margin of leaves glabrous 8
8. Leaves recurved or spreading, the portion of leaf seen above the ground short (first leaf $2\frac{1}{2}$ –6 cm long, 8–20 mm broad; length/width ratio usually 2–4); nerves distinctly elevated. Flowering pedicels erect-patent, about as long as blue perianth. Plants of Asia Minor (Plate III 9). *H. lineata* (Steud.) Chouard var. *glabrescens* (Boiss.) Feinbr.
- Plants not as above. Length/width leaf ratio usually exceeding 5 9
9. Leaves erect with prominently elevated nerves. Segments of perianth about $\frac{1}{3}$ as long as tube. Filaments inserted in upper part of tube. Plants of southern Russia, Romania (incl. Transilvania), southeastern Poland, Bulgaria, Greece and Yugoslavia (excluding Dalmatia) (Figure 1 A, Plate I 1–2). 11
- Leaves recurved or flaccid, usually very narrow, nerves indistinctly elevated or not elevated; segments of perianth about $\frac{1}{2}$ as long as tube 10
10. Pedicels much shorter than flowers. Perianth pale blue. Filaments inserted at the base of perianth segments. Leaves spreading. Plants of Dalmatia (Figure 1 B, Plate I 3). *H. dalmatica* (Baker) Chouard
- Pedicels about as long as flowers. Raceme very loose. Perianth blue-violet. Filaments about twice as long as anthers, inserted at the middle of tube. Leaves flaccid, often longer than scape. Plants of northern Persia (Figure 1 J, Plate IV 15). *H. persica* (Boiss. et Buhse) Chouard
- 11(9). Flowers pale-blue or white. *H. leucophaea* (C. Koch) Schur
- Flowers intensely blue. Plants of Greece. *H. atchleyi* (A. K. Jackson et Turrill) Feinbr.

ENUMERATION

Hyacinthella

Schur in Oest. bot. Wochenblatt 6: 227. 1856.

Bellevalia Sect. *Hyacinthella*, Boiss. Fl. or. 5: 301. 1884.

Bulb small. Leaves 2, rarely 1 or 3, usually provided with elevated nerves. Racemes cylindrical, bracts minute; flowering pedicels erect-patent or 0. Perianth campanulate or tubular or funnel-shaped, blue or violet, rarely white, 6-partite to about $\frac{1}{3}$ of its length, lobes \pm erect; stamens inserted below the bases of perianth segments, subbiserial; ovary globose or ovoid, style cylindrical. Capsule depressed-globose, carpels rounded at back, coriaceous; seeds 1-2 in each locule, black, wrinkled.

Type species: *H. leucophaea* Schur.

Geographical distribution: Southern Russia, southeastern Poland, Romania, Yugoslavia, Bulgaria, Greece, Asia Minor, Cyprus, Palestine, Syria, Iraq, northern Persia.

1. *H. leucophaea* (C. Koch) Schur in Oest. bot. Wochenbl. 6: 228. 1856 (Figure 1 A, Plate I 1-2)

Bulb ovoid, 1-1.5 cm in diameter. Leaves 2, rarely 3, linear-lanceolate, erect, 3-8 mm broad, about as long as scape, sometimes shorter, blade flat with elevated nerves, scabridulous at margin. Raceme oblong, 10-20-flowered, loose; pedicels erect-patent, as long as or slightly shorter than flowers. Perianth tubular-campanulate, 4-5 mm long, pale blue, rarely white, often turning green after flowering, segments ovate-elliptical, obtuse, about half as long as tube; filaments somewhat shorter than anthers, inserted at the upper $\frac{1}{5}$ of tube. Capsule depressed-globose, 3-4 mm high, valves rounded at back.

var. *leucophaea* (Plate I 1)

Muscari leucophaeum C. Koch in Linnaea 22: 254. 1849.

Hyacinthus leucophaeus Stev. ex Kth. Enum. 4: 312. 1843, nomen; Ledeb. Fl. ros. 4: 156. 1853, descr.

Bellevalia leucophaea (Stev.) Boiss. Fl. or. 5: 305. 1884.

ICON. Rchb. Pl. crit. 4: 1826, t. 331, under *Hyacinthus pallens*.

Type locality: Southern Russia.

Distribution: Southern Russia, southeastern Poland, Romania, Bulgaria, Yugoslavia (excluding Dalmatia).

Selected specimens: RUSSIA. Ex Rossiae mediae, *Bieberstein*, as *Hyacinthus pallens* (W); Elisabethgrad, 4. 1873 *Wiedemann* (W). ROMANIA. Transilvania: In montib. calc. Transilv. Schur (W); Dumbrava Orasului, 1908 *Richter* (BRNU 04381, W 6395*); in m. Zinne pr. Kronstadt** 960 m, 4. 1895 *Roemer* (W 3513, PRC); Bucovina: pr. Cernauti, 5. 1928 *Gusuleac* (BRNU); Moldova, pr. Barlad, 4. 1922 *Savulescu* 224 a (W 5610). SERBIA. In saxosis m. Vrska Cuke, 4. 1880 *Petrovic* (W); Mt. Basara 1000 m, 5. 1897 *Adamovic* (TU); pr. Nissam (Nisch) 1889 *Ilic* (W 406). BULGARIA. Tirnowo, 1897 *Urumoff* (W); Sipka 600 m, 6. 1930 (fruiting specimen) *Sirjaev* (BRNU); Mt. Rhodop, 6. 1906 *Adamovic* (W 13149).

var. *rumelica* (Vel.) Feinbr. comb. nov. (Plate I 2)

Hyacinthella rumelica Vel. Fl. Bulg.: 554. 1891.

Hyacinthella leucophaea (Stev.) Schur B. *rumelica* (Vel.) Hayek. Prodr. Fl. balcan. 3: 85. 1933.

Leaves narrower, tapering at both ends. Flowers pale sky-blue or white, 4 mm long.

Type locality: Southern Bulgaria.

Distribution: Southern Bulgaria (Rumelia).

* Plate I 1.

** Type locality of Schur.

Selected specimens: S. BULGARIA. In dumosis ad Stanimaka, 1892 *Stribny*, Det. *Velenovsky* (W 10831*); Bulg. austr., Nova Mohala, 4.1892, 1893 *Stribny* (PRC, W 1630); ad Papazli, 3.1909 *Stribny* (BRNU, TU).

H. leucophaea is the type species of the genus, and also happens to have the widest geographical range in the genus. Geographically it can be designated as a Sarmatic—Balkan species. It does not occur in Asia Minor as erroneously stated by Ascherson and Graebner (1905–1907). Within its area the species occurs at altitudes ranging from 200m to 1000 m.

The specimens from S. Bulgaria, var. *rumelica* (Vel.) Feinbr., possess narrower leaves, somewhat smaller flowers and apparently somewhat shorter pedicels. The variety should be studied on living plants in comparison with typical *H. leucophaea*.

As to var. *longiloba* (Vel.) Hayek, Prodr. Fl. balcan. 3:85. 1933 it does not seem to be a distinct taxon, since the length of perianth segments is not a constant character in this species.

In Dalmatia *H. leucophaea* is replaced by *H. dalmatica*.

Both *Hyacinthella leucophaea* and *H. dalmatica* have been repeatedly misidentified as *Hyacinthus pallens* M. B. (Reichenbach 1826; Visiani 1842, 1872; Kunth 1843; Ascherson and Graebner 1905–7). The latter epithet has to be referred as synonym to the Caucasian *Muscari pallens* (M. B.) Fisch. which is not sympatric with either of the two *Hyacinthella* species.

1a. *H. atchleyi* (See note added in proof, p. 339)

2. *H. pallasiana* (Stev.) A. Los. in Fl. USSR 4: 408. 1935 (Figure 1 C, Plate I 4)

Hyacinthus pallasianus Stev. in Bull. Soc. Nat. Mosc. 30,2:85.1857.

H. leucophaeus (C. Koch) Schur var. *pallasianus* Schmalh. Fl. sredn. i yushn. Ross. 2: 497. 1847.

ICON. Fl. USSR 4: 399.1935.

Bulb ovoid, small, about 1 cm in diameter. Leaves 2, linear, erect, 6–7 mm broad, as long as or somewhat longer than scape, blade flat, with elevated nerves and smooth margin. Raceme compact, ovate, few-flowered; pedicels upright, very short. Perianth blue with darker veins, funnel-shaped, 8–10 mm long, tube narrow, segments about $\frac{1}{3}$ as long as tube; filaments very short, inserted at the middle of tube. Capsule unknown.

Type locality: Crimea.

Distribution: Endemic in southern Russia.

Examined specimens: S. RUSSIA. Prov. Donetsk pr. Mariupol, 1927 *Kowalenko* 39 (HJ***, BRNU 269249); Ucraina, Mariupol, 1927 *Goliz* (BRNU 254920); Prov. Don, Zuevka, 1900 *Karasew* (TU).

This is a very distinct species endemic to the steppes of S. Russia and Crimea. The nearest species is *H. leucophaea*, which it resembles by its erect, prominently nerved leaves. But it differs by its much larger flowers, which are the largest in this genus, and by its stamens attached at the middle of the perianth tube.

* Plate I 2.

** Plate I 4.

3. *H. dalmatica* (Baker) Chouard in Bull. Mus. Hist. nat. Paris, Ser. II.3:178.1931
(Figure 1 B, Plate I 3)

Bulb ovoid, 1–1.5 cm in diameter. Leaves 2–3, linear-lanceolate, spreading or recurved, canaliculate, 2–6 mm broad, shorter than scape, margin scabrous, nerves not distinctly elevated. Raceme short - cylindrical, 3–20 - flowered, loose; pedicels patent, somewhat shorter than flowers. Perianth 4–5 mm long, tubular - campanulate, pale blue, segments obovate, slightly shorter than tube; filaments about as long as anthers, inserted at the base of segments. Capsule not seen.

var. *dalmatica*

Hyacinthus dalmaticus Baker in Proc. Linn. Soc. Bot. 11:428. 1871.

Hyacinthus pallens sec. Vis. Fl. dalm. 1:150. 1842, non M. B., i.e. non *Muscari pallens* (M. B.) Fisch.

Leaves 2. Flower 5 mm long.

Type locality: Dalmatia.

Distribution: Dalmatia, Bosnia, Hercegovina.

Selected specimens: YUGOSLAVIA. Dalmatia, Spaletto, *Petter*, type collection (W 276729); in collibus ad Malfi pr. Gravosa, 3. 1898, 2. 1899 *Rudolph* (PRC, W 8696); in m. Croatiae, Capella, 4. 1818 Hb. *Portenschlag* (W); Ragusa, *Adamovic* (W 4183); Lapad, 1911 *Berger* (W 10826, BRNU, GZU); Peljesac, 4. 1934 *Baumgartner* (W 7139 *).

Distinctive characters of this species are: Plants of smaller size than *H. leucophaea*, leaves narrow, canaliculate, recurved, with less prominent nerves containing fewer fibres. Racemes few-flowered. Pedicels horizontal, very short, perianth more campanulate with proportionately longer segments.

H. dalmatica is the westernmost taxon of this genus. It apparently had split off the more widely distributed *H. leucophaea* under the ecological conditions of the northern Adriatic coast. Its flowering time is February, March, and sometimes April, while *H. leucophaea* hardly starts flowering before April and goes on flowering in May.

var. *velezensis* (Beck.) Feinbr. comb. nov.

Hyacinthus dalmaticus var. *velezensis* Beck. Glasn. 8:322. 1896.

Hyacinthella dalmatica (Baker) B. *velezensis* (Beck.) Hayek, Prodr. Fl. balcan. 3:84. 1933.

Leaves 3. Flower 4 mm long. Plant of Bosnia - Hercegovina.

No specimens of this variety were available for examination and its validity is not clear. Hayek (1933) cites this form from the alpine belt of Bosnia - Hercegovina, and describes it as a smaller plant with 3 leaves and a 4 mm long perianth, the type form possessing 2 leaves and a 5 mm long perianth.

4. *H. lineata* (Steud.) Chouard in Bull. Mus. Hist. nat. Paris, Ser. II.3:178.1931
(Figure 1 D, Plates II 5–6, III 9)

Bulb ovoid, 1.5–2 cm in diameter. Leaves 2–3, ovate-lanceolate to lanceolate, shorter than scape, blade flat, spreading or ascending, with elevated nerves, ciliate-pectinate at margin, glabrous, sometimes with few whitish hairs underneath, or in var. *glabrescens* glabrous throughout; first leaf 7–15 mm broad, second leaf somewhat narrower. Raceme ovate, loose, 10–20-flowered; pedicels erect - patent, about half as long to as long as flowers. Perianth 5 mm long,

* Plate I 3.

azure-blue, campanulate, segments ovate, obtuse, about $\frac{1}{3}$ as long as tube; filaments slightly longer than anther, inserted somewhat below the bases of segments. Scape much elongated in fruit; fruiting pedicels straight, ascending, 6–12 mm long. Capsule depressed-globose, 3–4 mm high, valves rounded at back; seeds black, wrinkled.

var. *lineata* (Plate II 5–6)

Hyacinthus lineatus Steud. ex Roem. et Schult. Syst. 7: 584. 1830.

Bellevalia lineata (Steud.) Kth. Enum. 4:309. 1843.

Leaves ciliate-pectinate at margin.

Type locality: Smyrna (W. Asia Minor).

Type collection: prope Smyrnam, Fleischer 1927.

Distribution: Asia Minor (Caria, Phrygia, Cappadocia, Armenia Turcica).

Examined specimens: TURKEY. In flower: Caria, in fruticetis collinis Smyrnae, Febr. 1827 Fleischer, as *Hyacinthus ciliatus* Cyril (W 182809, PRC*); Cappadocia, Melekum, Siwas, 1898 Père Girard (G). In fruit: Phrygia, Ouchak, Mai 1857 Balansa (G**); Armenia Turcica, Egin, Altikioei, in quercetis, 4.1890 Sintenis 2364, as *Bellevalia hispida* J. Gay var. *glabrescens* (PRC, W 375).

Baker's (1871) *Hyacinthus lineatus* comprises *Hyacinthella lineata* var. *lineata* (Smyrna, Fleischer), *H. heldreichii* (Adalia, Heldreich), *H. lineata* var. *glabrescens* (Cappadocia, Montbret and Taurus, Aucher Eloy 2116). Under *Hyacinthus hispidus* Baker cites the fruiting specimen of *Hyacinthella lineata* var. *lineata* (Phrygia pr. Ouschak, Balansa).

var. *glabrescens* (Boiss.) Feinbr. comb. nov. (Plate III 9)

Bellevalia hispida J. Gay var. *glabrescens* Boiss. Fl. or. 5: 306. 1884.

Differs from var. *lineata* by glabrous non-ciliate, somewhat broader leaves and more erect and usually longer pedicels. $2n = 18$.

Type locality: Cilicia, Taurus.

Type collection: Taurus, Aucher Eloy 2116.

Distribution: Turkey (Cilicia).

Examined specimens: TURKEY. Taurus, Aucher Eloy 2116 lectotype (G); In Tauro, 1836 Aucher Eloy 1428 (G); Porta Ciliciae 1000m, 3. 1896 Siehe 29 (E***, G); Cilicische Paesse 1400m. 3. 1911 Siehe 52 (E, W 4150); Goelek, above Cilician Gates 3500 ft, 4. 1934 Balls 681 (E); prov, Adana, distr. Karaisali, Bürücek-Posanti 1000m, dry stony ground, 4. 1956 Polunin et Davis 26139 (E); Bürücek 1300m, 4. 1957 Davis et Hedge 26345 (E); Pozanti, 800m, dry grassy slopes, 4. 1957 in fruit, Davis et Hedge 26314 (E).

The chromosome number of var. *glabrescens* ($2n = 18$) was counted in a specimen collected at Bürücek (1300m) by P. H. Davis.

Boissier (1884) described this plant as a glabrous variety of *H. hispida*. However, comparison of the main characteristics of *H. hispida*, *H. lineata* and *H. heldreichii* convinced the present author that Boissier's var. *glabrescens* differs from *H. hispida* in several significant characters and not in lack of hairiness only. On the other hand, it is much closer to *H. lineata* especially in shape and size of leaves. Measurements of the length and width of the first leaf of *H. hispida*, *H. lineata* var. *lineata* and var. *glabrescens* showed that the leaves of var. *glabrescens* are much shorter and broader

* Plate II 5.

** Plate II 6.

*** Plate III 9.

than in *H. hispida*. The measurements are summarized in Table II. In addition, the second leaf of *H. hispida* is conspicuously narrower than the first one, while in var. *glabrescens* as in *H. lineata* the second leaf is only slightly narrower than the first leaf. Another distinctive characteristic of *H. hispida* lacking in var. *glabrescens* (apart from hairiness) are red spots or splashes on the sheath of leaves and on the lower portion of the scape. From *H. heldreichii*, which also possesses glabrous leaves, *H. lineata* var. *glabrescens* differs mainly by long flowering pedicels and by the blue (not violet) colour of the perianth.

The geographical relationships of the three *Hyacinthella* species are of interest. *H. heldreichii* is found in Pamphylia and Cilicia (S. Asia Minor), *H. hispida* in Cilicia. The typical *H. lineata* var. *lineata* is known from Caria, Phrygia, Cappadocia and Turkish Armenia, but has never been reported from Cilicia. The area of *H. lineata* var. *glabrescens* overlaps with that of *H. hispida* but according to Dr. Davis (in litt.) *H. hispida* grows in drier places. The occurrence of *H. lineata* var. *glabrescens* in Cilicia could be interpreted as the result of an expansion of *H. lineata* into Cilicia following the formation of a new intraspecific taxon, adapted to the ecological conditions of southern Asia Minor.

TABLE II
Comparison of length and width of first leaf in *H. hispida* and *H. lineata*

Name of plant	No. of specimens measured	Range of variation			Average length/width ratio
		Length	Width	Length/width ratio	
<i>H. hispida</i>	12	43-90 mm	6-17 mm	5-11	7.4
<i>H. lineata</i> var. <i>glabrescens</i>	16	25-60 mm	8-18 mm	1.8-6.9	4.5
<i>H. lineata</i> var. <i>lineata</i>	3	30-45 mm	5-11 mm	3.6-7.5	5.7

5. *H. hispida* (J. Gay) Chouard in Bull. Mus. Hist. nat. Paris, Ser. II. 3:178. 1931
(Figure 1 E, Plate II 7-8)

Bellevalia hispida J. Gay in Bull. Soc. bot. France 3: 240. 1856.

Bulb ovoid, small, 1-1.5 cm in diameter. Leaves 2, rarely 3, acute, wavy, spreading or recurved, sometimes canaliculate, with elevated nerves; sheath and blade covered with strigilous long hairs on both surfaces: outer leaf oblong-lanceolate, 5-10 times longer than broad (width 5-15 mm), second leaf linear, much narrower. Raceme oblong, loose, 10-15 - flowered; pedicels erect - patent, shorter than flower. Perianth 5mm long, intensely blue, campanulate, segments ovate, obtuse, about $\frac{1}{3}$ as long as tube; filaments slightly longer than anther, inserted in the upper $\frac{1}{4}$ of tube. Fruiting pedicels slightly elongating, arcuate, horizontal or somewhat ascending. Capsule depressed - globose, 3mm high, sulcate between rounded valves.

Distribution: Asia Minor (Cilicia).

Examined specimens: In fruit: Plaine de Mersina, 30.3.1855 *Balansa* 815 as *Scilla hispida* J. Gay mst. (E, G, W* W 259823, 153227); Plaine de Mersina, 4.1893 *Post* 411 (G). In flower:

* Plate II 8.

bei Mersina, Kalkhugel, 2.1896 *Siehe* 35 (E, G); Porta Ciliciae, 900m, 1896 *Siehe* 686 (G); Bei Station Dorak, Vilajet Adana, ca 150m, 2.1911 *Siehe* 301 (E, W 12227*); Ulukishla to Pozanti 3600ft, 4.1934 *Balls* 653 (E); betw. Tarsus and Namrum 3000ft, *Balls* 168 (E); 10 km N. of Tarsus, *Sauer* 19a (E).

Distinctive characteristics: Leaves 2, rarely 3, firm, spreading with several elevated nerves on both surfaces, margins and nerves on both surfaces bearing long strigilous hairs, inner leaf much narrower than the outer one. Flowering scape and lower part of leaves usually marked by red spots. The intensely blue flowers and the length of flowering pedicels similar to those of *H. lineata*, but the fruiting pedicels arcuate and usually shorter than in *H. lineata*.

Baker's (1871) *Hyacinthus hispidus* var. *platyphyllus* J. Gay, based on a specimen collected by Balansa in Phrygia (ad montem Mourad Dagħ) could not be examined. From the description of its leaves (ovate, 2.5–3cm broad) it seems that it might belong to *H. lineata* which has the broadest leaves of the genus.

6. *H. heldreichii* (Boiss.) Chouard in Bull. Mus. Hist. nat. Paris, Ser. II. 3:178. 1931
(Figure 1 F, Plate III 10)

Bellevialia heldreichii Boiss. Diagn. II. 4:111. 1859.

Bulb ovoid, 1.5–2.5 cm in diameter. Leaves 2–3, oblong-lanceolate, acute, shorter than the rather short scape, first leaf 8–10 mm broad, second leaf distinctly narrower, blade somewhat wavy, spreading or recurved, with elevated nerves, glabrous at margin and on both surfaces. Raceme cylindrical, often spike-like; pedicels erect - patent, very short, or none. Perianth 5mm long, dark blue - violet, campanulate, segments ovate, about $\frac{1}{3}$ as long as tube; filaments somewhat longer than anthers, inserted at the upper $\frac{1}{3}$ of tube. Capsule unknown. $2n = 18$.

Type locality: Between Adalia and Yenidje Khan (Pamphylia, Asia Minor).

Distribution: Asia Minor (Pamphylia, Cilicia).

Examined specimens: In flower: In fruticetis Pamphyliae pr. Adalia, 3.1845 *Heldreich* (E** W 276716, W 276719, W 23); in herbis Adaliae, 1845 *Heldreich* (E G); Ostcilicien, Vorberge des Taurus bei Sis 300m, Nur Dagħ bei Missis 200m, *Siehe*, as *Bellevialia sieheana* Hausskn. (W 4149); prov. Antalya, Kurkutei - Güllük dag 600m, *Pinus brutia* forest, 4.1956 *Davis* 25754 (E); ibid. distr. Akseki, Yarpuz dag 1200m, 4.1956 *Davis* 25785 (E).

The distinctive characters of *H. heldreichii* are glabrous leaves, almost sessile flowers and the dark colour of the perianth. The leaves are on the whole narrower and proportionally longer than in *H. lineata* var. *glabrescens*.

The chromosome number $2n = 18$ has been counted in a specimen from prov. Antalya, distr. Akseki, Yarpuz dag, 1200m, collected by P. H. Davis.

7. *H. millingenii* (Post) Feinbr. comb. nov. (Figure 1 H, Plate IV 12)

Bellevialia millingenii Post, Plantae Postianae 10: 101, 1900.

Bulb ovoid, small, 8–12 mm in diameter. Leaves 2, linear, about as long as scape, recurved, plicate, with elevated nerves, glabrous, often scabridulous or ciliolate at margin; first leaf 2.5–4 mm broad. Scape a few cms tall; raceme short, dense, 3–5-flowered. Flowers sessile; perianth 3–5 mm long, 2 mm broad, azure-coloured, campanulate, segments ovate, obtuse, about $\frac{1}{2}$ as long as tube; filaments inserted in upper part of tube. Capsule unknown.

Type locality: Nicosia (Cyprus).

Distribution: Cyprus, Asia Minor.

* Plate II 7.

** Plate III 10.

Examined specimens: CYPRUS. Cipro, 1859 *Samaritani*, as *Bellevaia sessiliflora* (Viv.) Kth. (RO); in collibus versus orientem a Larnaka, 20.2.1880 *Sintenis et Rigo* 856 (FI); noerdl. Kuestengebirge, Halbinsel Karpa, Felsen am Meere bei Macheriona, 1. 1894 *Deschamps* 479 (G PRC*); Nicosia, aerodrome, marly soil, 2.1944 *Evenari* (HUJ); Mia Malea, Chionistra, Merton (HUJ); betw. Kormakiti and Orga, limestone hills with *Romulea tempskyana*, 1.1941 *Davis* 2102 (E). S. TURKEY (Cilicia): above Namrum 4200 ft, 4.1933 *Balls* 177 and part of 189 (E); Adana to Amanus, Sis 300m, *Siehe* 53 (E); Gülnar, 1950 *Attila* 52 (K det. *Davis*).

Post (1900) pointed out that this species is nearest to *H. nervosa*, from which he distinguished it by smaller size, narrower linear leaves but mainly by much smaller flowers (4–5 mm long). It is true that the leaves of *H. millingenii* are sometimes minutely ciliolate as in *H. nervosa* and are even more strongly recurved and canaliculate. However, its closest connections seem not to be with the steppical *H. nervosa* but with the East Mediterranean group of species centering in Asia Minor, i.e. *H. hispida*, *H. lineata* and *H. heldreichii*. At first *H. millingenii* was thought to be endemic in Cyprus, but later Dr. P. H. Davis called our attention to several specimens of this species collected in Cilicia which he identified as *H. millingenii*. It should be pointed out however that some of the Cilician specimens are not typical (leaves broader and flowers more numerous). In addition, the time of flowering in Cyprus is in January–February, whereas the Cilician specimens were collected in April. Dr. Davis (personal communication) suggests that introgression from var. *glabrescens* or *H. heldreichii* may have caused the occurrence of such untypical specimens.

In Cyprus *H. millingenii* is fairly common all over the island, except in the Troodos Mts. and it seems that the plant avoids igneous rocks. The fact that this species occurs both in Cyprus and in Cilicia indicates that it already existed in Middle Pleistocene, when there was continental connection between Cyprus and the south-eastern part of Asia Minor.

8. *H. nervosa* (Bertol.) Chouard in Bull. Mus. Hist. nat. Paris, Ser. II. 3:178. 1931. (Figure 1 G, Plate III 11)

Hyacinthus nervosus Bertol. Miscell. 1:21.1842.

Hyacinthus sessiliflorus Baker p.p. in Proc. Linn. Soc. Bot. 11:428. 1871.

Hyacinthus haynei Baker in J. Bot. 12: 7. 1874.

Bellevaia nervosa (Bertol.) Boiss. Fl. or. 5: 306. 1884.

Bellevaia aleppica Boiss. Diagn. II. 4: 111. 1859.

Bulb ovoid, 1.5–2 cm in diameter. Leaves 2, rarely 1 or 3, oblong or lanceolate-linear, about as long as or longer than scape, curved, wavy, often canaliculate, with elevated nerves, margin ciliolate, first leaf 5–20 mm broad. Raceme oblong, dense, many-flowered; pedicels very short. Perianth 6–8 mm long, azure-blue, tubular-campanulate, segments ovate, $\frac{1}{3}$ as long as tube; filaments longer than anthers, inserted at the upper $\frac{1}{4}$ of tube; anthers dark-violet, almost exerted. Fruiting pedicels hardly elongating. Capsule depressed-globose, 2.5–3 mm high; seeds ovate, black, wrinkled. $2n = 24$.

Type locality: Port William (N. Syria).

Distribution: Palestine, Syria, northern Iraq, eastern Turkey.

Examined specimens: SYRIA. In collibus calcareis pr. Aleppum, 3. 1841 *Kotschy*, as *Muscari ciliatum*; type of Boissier's *Bellevaia aleppica* (G, W 276718); in gramin. c. Aleppo, 1300', 12.3.1865 *Haussknecht* (W 56072**); Euphrates, Port William, March 1836, *Col. Chesney* 11

* Plate III 12.

** Plate III 11.

(G,W); Alep, *Aucher Eloy* 2199 bis et 2673 (G); d'Alep à Mossul, herb. d'Olivier 1822 as *Hyacinthus (Bellevia) exsculptus* Baker n. sp. (G); Aleppo inter Hamam et Afrin, in collibus, 3.1888 *Sintenis* 172 (E, G, P, PRC); ca Aleppo, 5.1931 (in fruit) *M. Zohary* (HUI); N. Syria, Jebel Muqeibra, W. of Soukne, 800 m, 5. 1933 *Eig et Zohary* (HUI); Syrian Desert, Deir Mar Musa—Deir Ati'yeh 5500ft, 4.1943 *Davis* 5582A (E). N.W. IRAQ. Jabal Sindjar, 830 m, 4.1933 *Eig et Zohary* (HUI). E. TURKEY. Killis to Aintab, 1893 *Post* (HUI): Gaziantep 3200ft, 4.1934 *Balls* 781 (E); N. of Gaziantep 1100m (in fruit) 5.1957 *Davis et Hedge* 28045 (E). PALESTINE Lower Jordan Valley, Ain Duq, 2.1929 *Gabrielith* (HUI); Judean Desert, Ain Auja, 7.2.1931 *Feinbrun et Zohary* (HUI); Auja River, - 200 m, 22.2.1911 *Meyers et Dinsmore* 1541 (HUI); ibidem, as *Bellevia? haynei* Baker (G); Edom, Petra to foot of Mt. Hor (in fruit), 4.1945 *Davis* 8659 (E).

H. nervosa is an Irano - Turanian species. It usually grows in steppes on calcareous ground. In this genus it is prominent by its large sessile flowers.

The specimen of *Bellevia nervosa* from Cyprus mentioned by Boissier (coll. Samaritani) is to be referred to *Hyacinthella millingenii*, the specimens from Aleppo and Euphrates cited by Baker (1871) under *Hyacinthus sessiliflorus* Viv. are *H. nervosa* (Bertol.) Chouard.

The chromosome number $2n = 24$ was counted in a specimen collected by P. H. Davis near Gaziantep (S. E. Turkey).

9. *H. micrantha* (Boiss.) Chouard in Bull. Hist. nat. Paris, Sér. II. 3:178. 1931 (Figure 1 J, Plate IV 13-14)

Bulb ovoid, small, 7-15 mm in diameter. Leaves 2, linear-filiform, canaliculate, spreading or recurved, about as long as scape, glabrous, sometimes short-puberulent, 3-5 mm broad; nerves not elevated. Scape flexuous. Raceme ovate, few-flowered. Flowers sessile, horizontal; perianth 2.5-4 mm long, pale blue, ovate-campanulate, segments ovate obtuse, $\frac{1}{4}$ - $\frac{1}{3}$ as long as tube; filaments shorter than anthers, inserted at the upper third of the tube. Capsule unknown.

var. *micrantha* (Plate IV 13)

Bellevia micrantha Boiss. Diagn. I.5: 63. 1844.

Hyacinthus micranthus Baker in Proc. Linn. Soc. Bot. 11: 430. 1871.

Leaves glabrous.

Type locality: Asia Minor.

Type collection: Asia Minor, *Aucher Eloy* 2115.

Distribution: Southern and eastern Asia Minor (Cilicia, Galatia).

Examined specimens: TURKEY. Asia Minor, *Aucher Eloy* 2115 lectotype and isotype (G*); in Tauro, 1836, *Aucher Eloy* 1411 (G); Gaensin (Cilicien) 1000m, Kalk, März 1896 *Siehe* 683 (G); Paphlagonia, Wilajet Kastambuli, Tossia, Schechdere, 5.1892 *Sintenis* 3925 (together with *Muscari neglectum*; E)

var. *puberula* (Hausskn. et Bornm.) Feinbr. comb. nov. (Plate IV 14)

Bellevia micrantha Boiss. var. *puberula* Hausskn. et Bornm. in Exsic.

Leaves puberulous.

Type locality: Amasia, Anatolia Orientalis.

Type collection: Amasia, *Bornmueller* 5.

Examined specimens: TURKEY. Anatolia Orientalis, Amasia, in lapidosis mts. Kirkclar 6-900m, 3. 1889 *Bornmueller* 5 (FI, GZU 1098, K, PRC** lectotype, W 1190, 10470).

* Plate IV 13.

** Plate IV 14.

The distinctive characteristics of the leaves of *H. micrantha* are: leaves recurved, canaliculate, somewhat fleshy and with slightly elevated nerves but without fibres at the vascular bundles (Figure 3 I); margin of leaf ciliolate. Boissier (1844) described the leaves as glabrous. Later Haussknecht and Bornmueller distributed specimens with puberulent or scabrous nerves under *Bellevalia micrantha* Boiss. var. *puberula* Hausskn. et Bornm. var. nov. This variety has not been published to the present author's knowledge. Ten sheets of Bornmueller's No. 5 containing several scores of plants have been examined. They give a fairly good representation of a population and show considerable variability in the degree of hairiness from dense through short puberulence to an almost glabrous condition. Though several specimens from Aucher's type collection, N. 2115 (Boissier's type) show some scabrosity along the leaf nerves, it seems worthwhile to describe var. *puberula* in order to emphasize the intraspecific variability in this character.

The length of the flower is given by Boissier as "vix lineam" (1884) and "vix sesquilineam" (1859). In the examined specimens the length of the perianth varies from 2.5 to 4 mm; there is also variation in the width of perianth; the perianth segments are often as long as tube.

H. micrantha occurs mainly in Cilicia. Boissier cites "Bithynia (Pestal. !)" and "Anatolia borealis (Auch. 2115)". However, two specimens by Aucher distributed under No. 2115 which belong to the type collection are marked "Asia Minor" and a third specimen (Aucher No. 1411) is marked "In Tauro". The pubescent specimens originate from Amasya (Galatia, N. Asia Minor).

H. millingenii is very similar to *H. micrantha* in having small sessile flowers and canaliculate recurved and narrow leaves. However, the leaves of *H. micrantha* are apparently quite different in texture. They are somewhat fleshy and their nerves do not contain the characteristic fibres (Figure 2 H). The leaves blacken when dried, whereas in *H. millingenii* they are tawny. The two species should be compared also on living material. It seems that they are not closely related.

10. *H. persica* (Boiss. et Buhse) Chouard in Bull. Mus. Hist. nat. Paris, Sér. II. 3:178. 1931 (Figure 1 J, Plate IV 15)

Hyacinthus persicus Boiss. et Buhse in Enum.: 213. 1860.

Bellevalia persica (Boiss. et Buhse) Boiss. in Fl. or. 5: 308. 1884.

Bulb ovoid, 2–2.5 cm in diameter. Leaves 2, linear, canaliculate, flaccid, flexuous, as long as scape, scabridulous at margin, 3 mm broad; nerves not elevated. Scape flexuous; raceme 6–8-flowered; pedicels about as long as flower. Perianth 6–7 mm long, blue-violet, campanulate, segments oblong, obtuse, half as long as tube; filaments twice as long as anthers, inserted in the middle of tube, anthers included. Capsule unknown.

Type locality: Mendjil (Northern Persia).

Type collection: Mendjil Persiae borealis, Buhse.

Distribution: Northern Persia.

Examined specimens: N. PERSIA, pr. Mendschil, 1849 Buhse, lectotype (W 56094*).

* Plate IV 15.

This species is characterized by its long-pedicelled flowers, by its proportionately long perianth segments and by its narrow leaves with indistinct nerves.

Whether this species should be classed within *Hyacinthella* cannot be decided until capsules and seeds of this plant are available for examination.

This is the easternmost species of *Hyacinthella*.

Muscari azureum Fenzl (Figure 1 K, Plate IV 16)

The following specimens were examined: Taurus, Schott (W); Amassia, Galatia, Manissadjun 165 (G); Cilicien, Hadschin Dag 1500 m, Maerz 1896, *Siehe* 684 (E, G).

The chromosome number $2n = 18$ was counted in plants collected by P. H. Davis in S. Turkey (Cilicia, Prov. Adana, distr. Pozanti, Bürücek, 1300 m). The chromosome morphology is quite distinct from that of the *Hyacinthella* species in which $2n = 18$ has been also found.

NOTE ADDED IN PROOF

H. atchleyi (A. K. Jackson et Turrill) Feinbr. comb. nov.

Bellevalia atchleyi A. K. Jackson et Turrill in Hooker's Icones Plantarum: t. 3329.1937.

Differs from *H. leucophaea* mainly by intensely blue and slightly larger flowers (4.5–6 mm).

Type locality: Mt. Kithaeron, betw. Erythrai and Thebes (Greece).

Distribution: Greece.

Specimen examined: GREECE, Thebes distr., Kriekouki, Goulimis (HUI).

Regrettably this Greek plant came to the author's attention only when the paper was already in press. It is closest to *H. leucophaea*, especially by its erect leaves, and should be possibly regarded as a variety or subspecies of *H. leucophaea*. Further collections in Greece and study of living plants are most desirable. The specimen examined has been kindly supplied by Dr. C. N. Goulimis (Athens).

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The author is very much indebted to Dr. P. H. Davis who read this paper very thoroughly in manuscript and gave his valuable criticism and advice. Dr. Davis also kindly sent his *Hyacinthella* collections for study and supplied the author with root tips for chromosome counts. Sincere thanks of the author are also due to the Directors of those Herbaria who kindly lent material for examination, to Dr. A. Fahn for advice in connection with the leaf anatomy of *Hyacinthella*, and to Mr. A. Grizi for technical help.

LIST OF TAXA COMPRISED IN *HYACINTHELLA*

1. *H. leucophaea* (C. Koch) Schur var. *leucophaea*
2. *H. leucophaea* (C. Koch) Schur var. *rumelica* (Vel.) Feinbr.
3. *H. pallasiana* (Stev.) A. Los.
4. *H. dalmatica* (Baker) Chouard var. *dalmatica*
5. *H. dalmatica* (Baker) Chouard var. *velezensis* (Beck.) Feinbr.
6. *H. lineata* (Steud.) Chouard var. *lineata*

7. *H. lineata* (Steud.) Chouard var. *glabrescens* (Boiss.) Feinbr.
8. *H. hispida* (J. Gay) Chouard
9. *H. heldreichii* (Boiss.) Chouard
10. *H. millingenii* (Post) Feinbr.
11. *H. nervosa* (Bertol.) Chouard
12. *H. micrantha* (Boiss.) Chouard var. *micrantha*
13. *H. micrantha* (Boiss.) Chouard var. *puberula* (Haukskn. et Bornm.) Feinbr.
14. *H. persica* (Boiss. et Buhse) Chouard
15. *H. atchleyi* (A. K. Jackson et Turrill) Feinbr.

SPECIES TO BE EXCLUDED FROM *HYACINTHELLA*

- Hyacinthella azurea* (Fenzl) Chouard = *Muscari azureum* Fenzl
H. kopet-daghii (Czern.) Chouard = *Hyacinthus kopet-daghii* Czern.
H. nivalis (Baker) Chouard = *Bellevalia nivalis* Boiss. ex Ky.
H. paradoxa (F. et M.) Chouard = *Muscari paradoxum* (F. et M.) Fisch.
H. pseudo-muscari (Baker) Chouard = *Muscari pseudo-muscari* Baker
H. pycnantha (Baker) Chouard = *Muscari pycnanthum* C. Koch
H. tabriziana Turrill = *Bellevalia tabriziana* (Turrill)
H. transcaspica (Litw.) Chouard = *Hyacinthus transcaspicus* Litw.
H. turkewiczii Woronow = *Muscari turkewiczii* (Woron.) A. Los.

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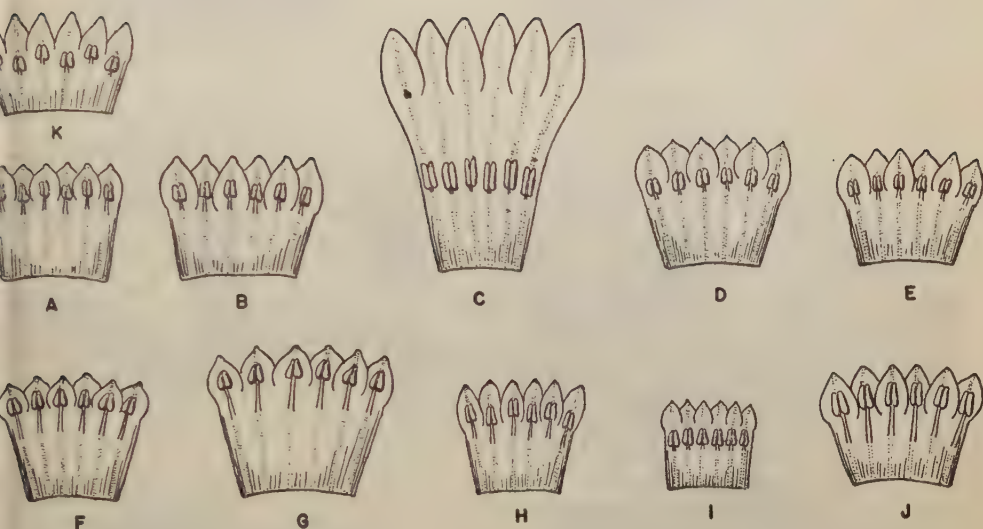


Figure 1

Perianth expanded showing insertion of stamens

A. *H. leucophaea* (C. Koch) Schur. Thracia, Mt. Rhodope; B. *H. dalmatica* (Baker) Chouard. S. Dalmatia; C. *H. pallasiana* (Stev.) A. Los. S. Russia, Don distr. 1900; D. *H. lineata* (Steud.) Chouard. Smyrna, Fleischer 1827; E. *H. hispida* (J. Gay) Chouard. Adana 1911; F. *H. heldreichii* (Boiss.) Chouard. Cilicia 1894; G. *H. nervosa* (Bertol.) Chouard. Palestine, Aujah River, Meyer, 1911; H. *H. millingerii* (Post) Feinbr. Cyprus Macheriona 1894; I. *H. micrantha* (Boiss.) Chouard. Tauro Cilic. 1836; J. *H. persica* (Boiss. et Buhse) Chouard. N. Persia, Mendschil 1848; K. *Muscari azureum* Fenzl. Taurus.

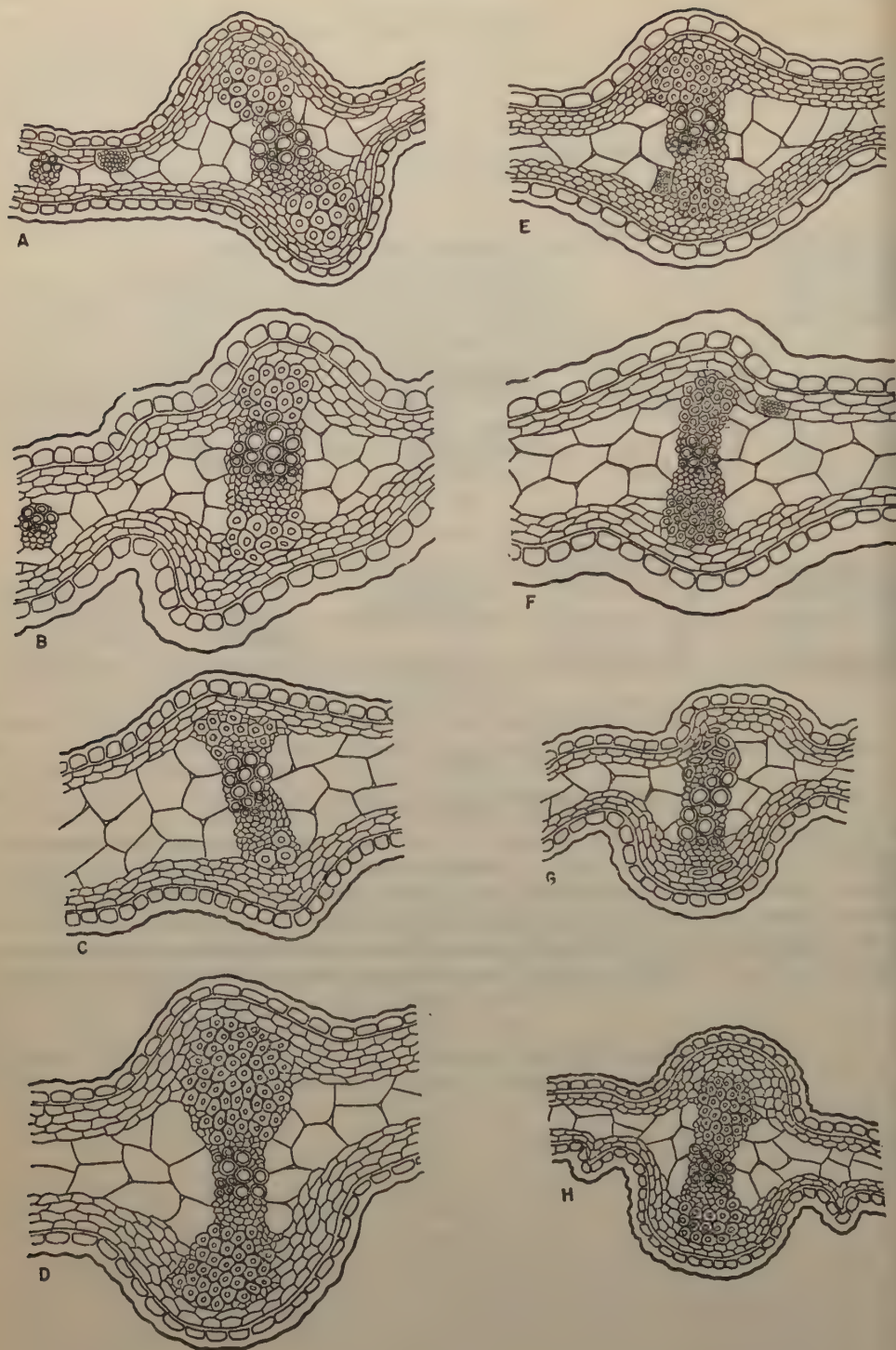


Figure 2

Cross sections of leaves

A. *H. leucophaea*; B. *H. pallasiana*; C. *H. dalmatica*; D. *H. lineata*; E. *H. hispida*; F. *H. heldreichii*; G. *H. scaberrimus*; H. *H. annuus*



Figure 3

Cross sections of leaves

I. *H. micrantha*; J. *H. persica*; K. *Muscari azureum*.

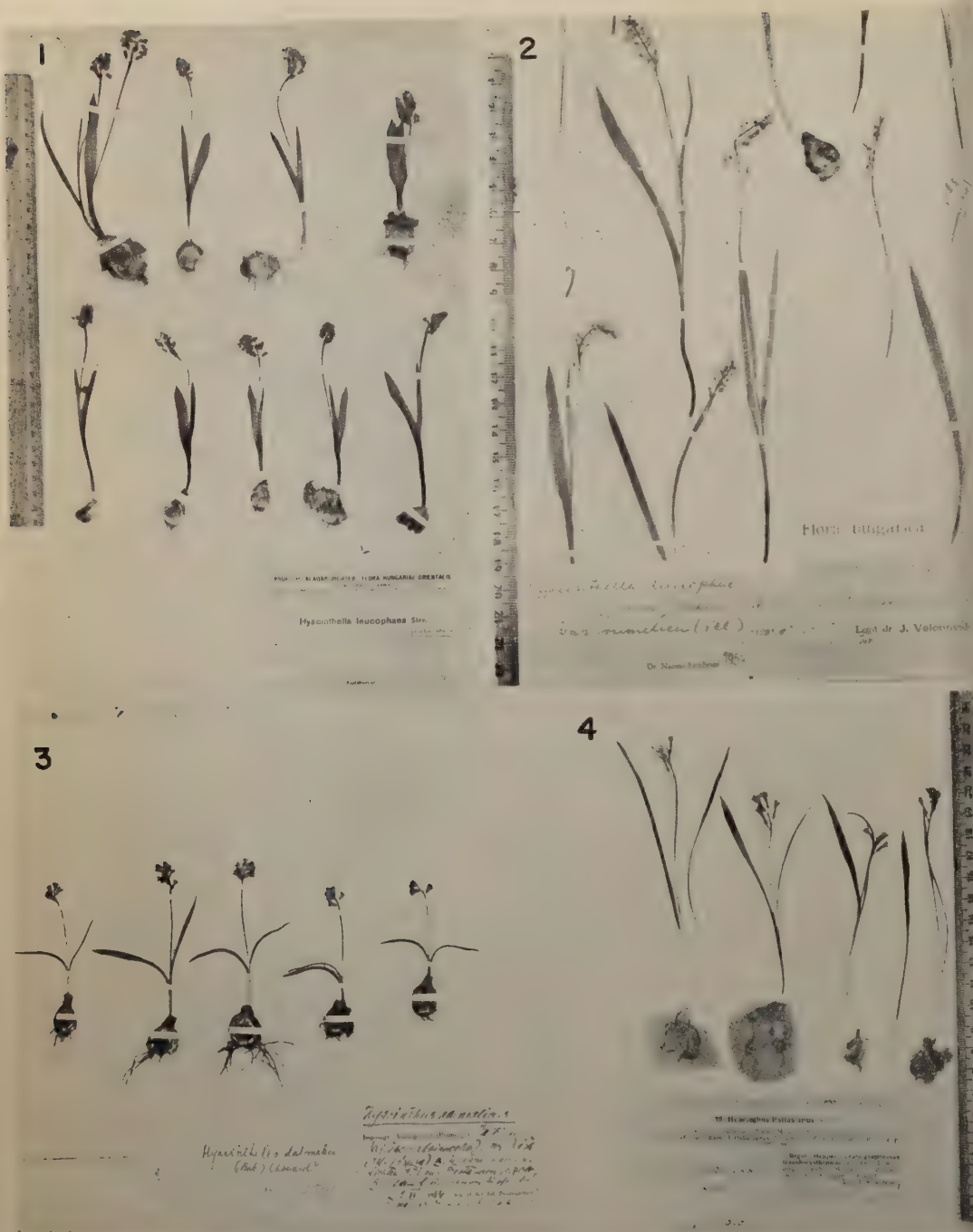


Plate I

1. *H. leucophaea* (C. Koch) Schur; 2. *H. leucophaea* var. *rumelica* (Vel.) Feinbr.; 3. *H. dalmatica* (Baker) Chouard; 4. *H. pallasiana* (Stev.) A. Los.

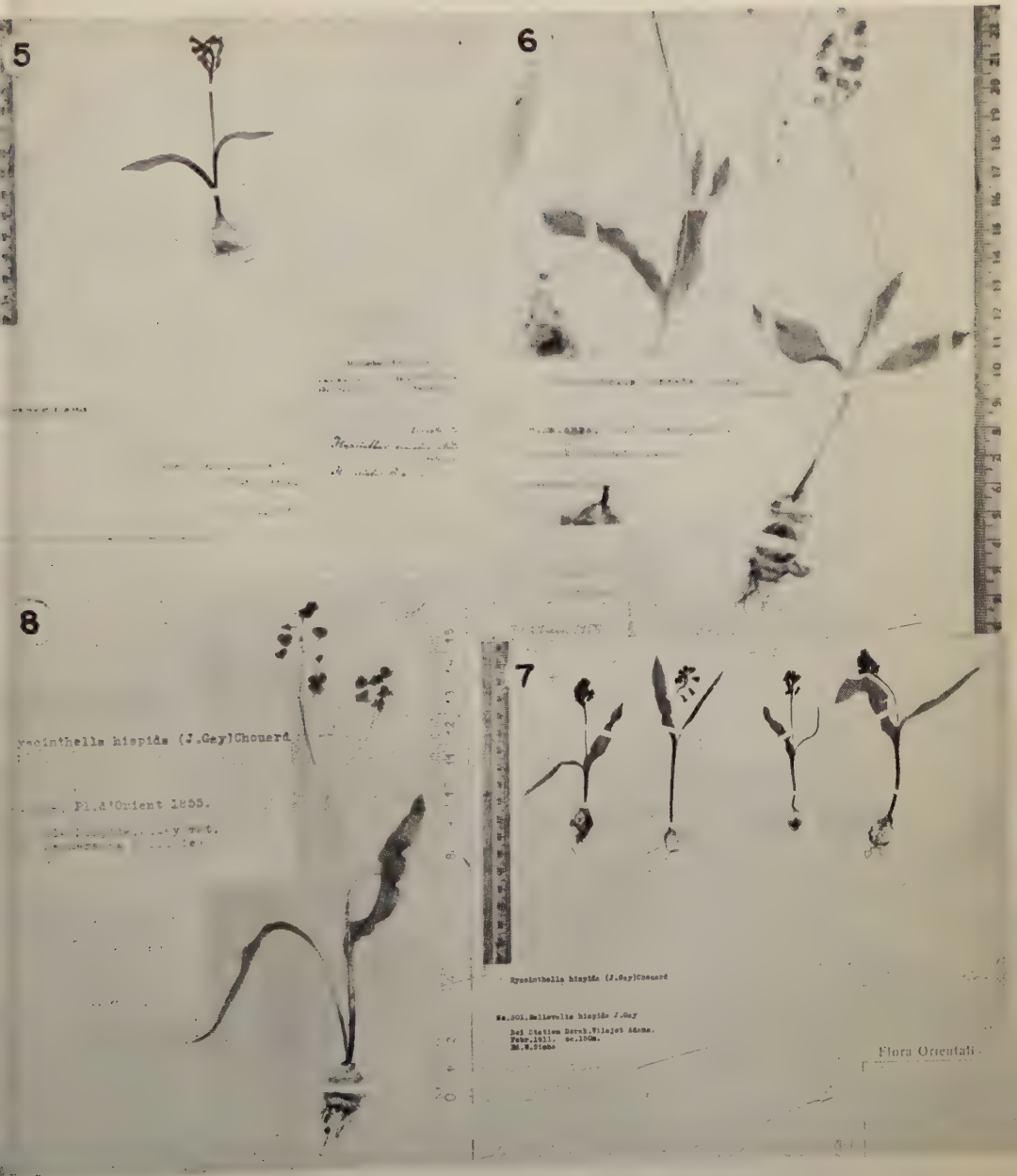


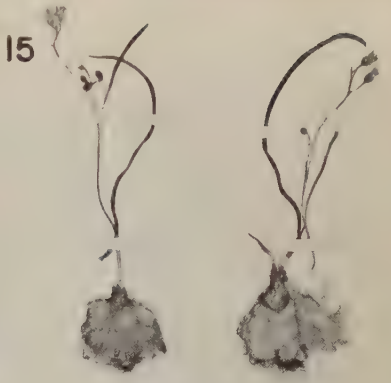
Plate II

5. *H. lineata* (Steud.) Chouard var. *lineata* (in flower); 6. idem (in fruit); 7. *H. hispida* (J. Gay) Chouard (in flower); 8. idem (in fruit).



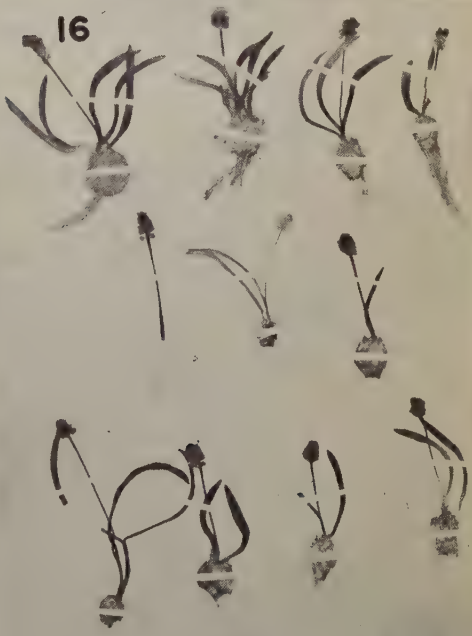
Plate III

9. *H. lineata* var. *glabrescens* (Boiss.) Feinbr.; 10. *H. heldreichii* (Boiss.) Chouard (type locality);
11. *H. nervosa* (Bertol.) Chouard; 12. *H. millingenii* (Post) Feinbr.



H. persica
Boiss. & Buhse n. sp.
B. Mendel, 1840
Cn. 112. 1840

Hyacinthella persica
(Boiss. & Buhse) Chouard



HERCULUM
MUSCARI
VINDOBONENSIS

Plate IV

13. *H. micrantha* (Boiss.) Chouard; 14. *H. micrantha* var. *puberula* (Hausskn. et Bornm.) Feinbr.;
15. *H. persica* (Boiss. et Buhse) Chouard; 16. *Muscari azureum* Fenzl = *H. azurea* (Fenzl) Chouard.

THE PERIANTHIUM OF *ARISTOLOCHIA ELEGANS* MAST.

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ABSTRACT

The perianthium is *not* compounded of several united leaves but consists of only a single leaf (like the spathe of the Araceae). This is evidenced by both the nervation and the development.

The relationships of the remarkable family Aristolochiaceae are still problematical. This is partly due to the fact that the structure of the flower has been misunderstood. Ever since the days of Eichler (1878), the views of this great researcher have prevailed. He assumed that the perianth of *Aristolochia* is made up of six coalescent leaves; and this opinion is based 1) upon a comparison with *Asarum* (Figure 14), and 2) on the number of vascular bundles in the perianth. It will be shown below, however, that the perianth of *Aristolochia* consists of only *one* single leaf built in a similar way as, for instance, the spathe of the Araceae.

A direct comparison with *Asarum* is of doubtful value, because the flower in this genus (Figure 14) is not zygomorphic like that of *Aristolochia* (Figure 2). Also in other respects these two flowers are much too different to allow far-reaching conclusions on the analogy between them.

In order to clarify the morphology of the perianth, it is vitally important to know its development. This is best investigated by means of a series of microtome sections through the tips of shoots, a method not known to the older morphologists. Thus Payer (1857) for instance, had not found the youngest stages in the development of the flower. But even his older stages showed no indication that the perianth developed from several coalescent primordia.

Studies of shoot tips are rendered difficult, however, by the fact that in many species accessory buds can be formed in most axils (Weisse 1927). I had six living specimens at my disposal, and of these *A. elegans* had the simplest branching, for which reason it was chosen for study (Figures 1-8).

The expanded flower of *A. elegans* (Figure 2) is so unique that it is difficult to compare it with any other flower. It stands in the axil of a supporting leaf, *D* (Figure 1) and has one single adaxial prophyll, *f*, like in most monocotyledons. But in other species there are several prophylls, which can even be transversal (Weisse 1927).

Received May 30, 1960.

*Deceased.

On vegetative shoots the leaves are in two vertical rows (Figure 8, $2\frac{1}{2}$ - spiral). The first, which is below a flower, is a small hemispherical axis (Figure 3, *a*) in the axil of the supporting leaf *D*. The first leaf of *a* is the prophyll, *f*, on the back of the flower. Leaf number two, *c*, appears on the front; in Figure 4-6 it is emphasized by radial shading. At first (Figure 4) *c* has an approximately semilunar shape as is usual with most early primordia of leaves. But soon (Figures 5-6) *c* becomes a circular rampart whose margins approach each other and coalesce surrounding the stem apex.

During the continued growth of *c*, this leaf develops so as to consist of different parts (Figures 1-2), viz. an urceolate part below the place where the margins have coalesced, and above this ureceolus an inequilateral leaf-like piece (limb) with free margins.

During the entire development of *c*, right from the youngest stages (Figures 4-5), there is nothing at all to indicate that *c* should have arisen from several (6) coalescent primordia, as had been the current concept for more than a century.

In order to find out whether in other species too, the perianth consists of only one single leaf, studies were also made of *A. clematitis* L. (Figure 9), *A. trilobata* L. and *A. grandiflora* Sw. (Figure 10). Also in these species the first primordium of the perianth is a *single* continuous rampart, which has *not* arisen from *several* fused parts.

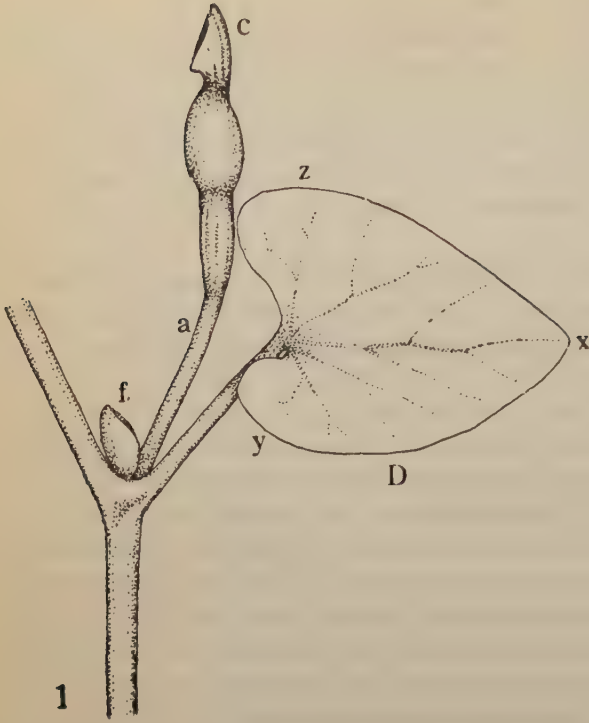
Since nervation has also played an important part, for instance in regard to Eichler's opinions, this was also investigated in the *first* primordia of the leaves. In the case of the perianth, this is to be found in the tip (Figure 1, *c* and Figure 11) which typically has five main nerves. This is also the case with the *quite* young primordia of vegetative leaves (Figure 12); and the petioles likewise have *primarily* five prominent nerves.

I had herbarium material of about 150 species at my disposal. In most of these there are five (to seven) heavy nerves in the lamina. It is striking, and hardly accidental, how much the two sections in Figures 11 and 12 resemble one another.

In older leaves numerous *secondary* nerves soon develop and blur the primary nervation. This also applies to the urceolate basal part of the perianth (Figure 7) where, among others, a thick bifurcated nerve is formed just under the point (Figure 7, *w*) where the two margins of the leaf are united. This is perhaps what Eichler had taken as evidence of the existence of six coalescent leaves.

The youngest open limb of the perianth (Figure 1, *c*) corresponds to the lamina of the vegetative leaves (Figure 1, *D*). In both, the innermost of the typical five primary nerves terminates in the limb tip (*x* in Figures 1-2), whilst the other four nerves lie in pairs at the sides of the leaves, *y* and *z*. In certain species, e.g. *A. trilobata*, the vegetative leaves are clearly three-lobed; and a similar tripartition also arises in the tip of the perianth in many species (Figure 2). This has led certain investigators to think that such a three-lobed perianth had been made up of three coalescent leaves.

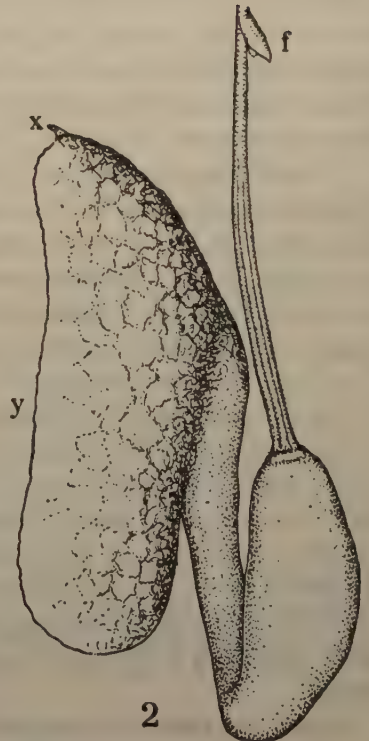
This is not correct at least for the species investigated here.

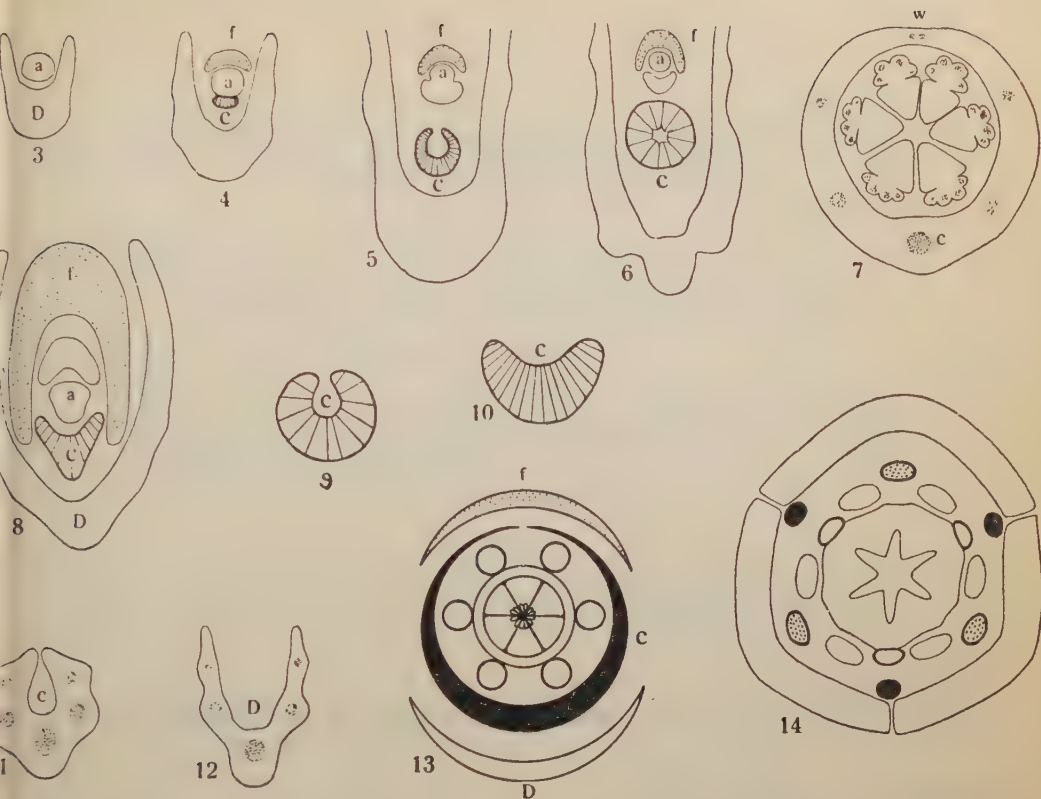


Figures 1-2

Aristolochia elegans. Figure 1. Young flower (a-c) with its supporting leaf (D) with 3 lobes (x, y and z). f. prophyll. $\times 5$.

Figure 2. Expanded flower. $\times 5/4$. See text.





Figures 3-8 and 11-13

Aristolochia elegans. D, supporting leaf; a, axis of the flower; c, perianth; f, prophyll. Figures 3-7. Development of the flower in transverse sections. $\times 35-50$. Figure 8. Vegetative shoot, transverse section of the tip. $\times 75$. Figure 11. Tip of young perianth with 5 nerves. $\times 50$. Figure 12. Transverse section of young leaf. $\times 50$. Figure 13. Diagram of flower. Figure 14. *Asarum europaeum*. Transverse section of flower. $\times 35$.

Figure 9

Aristolochia clematitis. Young perianth. $\times 75$.

Figure 10

Aristolochia grandiflora. Young perianth. $\times 75$. See text.

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NEW ADDITIONS TO THE MOSS FLORA OF PALESTINE AND THE NEIGHBOURING COUNTRIES

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ABSTRACT

A systematic list comprising 28 moss species is given. Of these, 5 are apparently new to the area; the others are mostly new records from the districts mentioned.

POTTIALES

Gymnostomum calcareum Br. Ger.

P*: Env. of Rehovot, II. 1954. N.

Leptobarbula berica (De Not.) Schpr.

UJ: Env. of Shear Yashuv, on exposed stone, II. 1945 K; Wadi Jalud opposite Sede Nahum, on a stone, II. 1945 K.

Trichostomum crispulum Bruch.

J: Deir es Sheikh, II. 1943 K.

Timiella barbula (Schwaeg.) Limpr.

LG: Env. of Nazareth, on rocks, III. 1954 N; env. of Beit Qeshet, on calcareous rocks, III. 1954 N; IX. 1943 K. Sa: Between Shefeiya and Bat Shelomo, maquis, IV. 1954 G. UJ: Susita, in shade, IV. 1954 G. UJ: Susita in shade, III. 1943 K; Wadi Hindaj, on basalt, IV. 1954 W; Tiberias, hot springs, XI. 1954 F.

ABBREVIATIONS

Districts: Ca—Mt. Carmel, J—Judean Mts., Le—Lebanon, including those parts of Mt. Hermon belonging to Syria, LG—Lower Galilee, LJ—Lower Jordan Valley, P—Philistaeen Plain, S—Sharon Plain, Sa—Shomron (Samaria), UG—Upper Galilee, UJ—Upper Jordan Valley, WN—Western Negev.

Collectors: F—N. Feinbrun, G—A. Grizi, K—T. Kushnir, Ka—A. Kadman-Zahavi, L—N. Landau, N—S. Nachmony, W—Y. Waisel.

Other signs and abbreviations: *—New to the area, c.fr.—cum fructificatione.

Received October 26, 1960.

***Tortella tortuosa* (L.) Limpr.**

UG: Wadi Qarn, IV. 1954 *Ka*. J: Env. of Jerusalem, on a stone in a pine wood, I. 1954 *N*.

***Tortella caespitosa* (Schwaegr.) Limpr. [= *T. humilis* (Hedw.) Jennings.]**

S: Pardess Hanna, III. 1943 *K*; Heftsi-Bah, III. 1954 *Ka*; near Ilanoth, on the Tel Aviv-Haifa road, garigue, III. 1954 *N*. LG: Sartaba, in Nazareth Mts., III. 1944 *K*.

***Barbula vinealis* Brid.**

Le: Hasbani Bridge near Sukher-Khen, X. 1943 *K*; Baniass, IV. 1945 *K*.

***Barbula vinealis* Brid. var. *cylindrica* (Tayl.) Bowl.**

Le: Faradis, X. 1943 *K*.

***Acaulon triquetrum* (Spruce) C.M., c.fr.**

S: Heftsi-Bah, III. 1942 *K*; J: Env. of Jerusalem, II, III. 1943 *K*.

***Phascum cuspidatum* Hedw. [= *P. acaulon* L.] c.fr.**

S: Env. of Pardess Hanna, III. 1943 *K*. P: Ramat Gan, II. 1943 *K*. LG: Env. of Nazareth II. 1944 *K*. J: Env. of Jerusalem, on exposed stones, II, III. 1943 *K*.

***Pottia strakeana* (Hedw.) C.M., c.fr.**

WN: Without exact locality, III. 1954 *N*.

***Pottia commutata*, Limpr.**

J: Jerusalem, III. 1943 *K*.

***Alonia rigida* (Schreb.) Kindb. var. *pilifera* Par.**

WN: West of Tel Yeroham, in a Poterietum, III. 1954 *N*.

***Tortula muralis* (L.) Hedw.**

UG: Wadi Qarn, IV. 1954 *Ka*. P: Nahalat Yehuda, XII. 1954 *N*. Sa: Without exact locality, III. 1945 *K*; Han Luban, III. 1945 *K*; Shefciya, IV. 1937 *L*, *ibid.*, IV. 1954 *G*. J: Sha'ar Hagai, I. 1954 *N*; Ein Kerem, II. 1954 *N*; Jerusalem, on soil, III, IV. 1943 *K*, *ibid.*, III, X. 1954 *N*.

Le: Baalbek, X. 1943 *K*; Baniass, IV. 1945 *K*.

***Tortula muralis* (L.) Hedw. forma *incana* Moenke.**

LG: Kefar Hahoresh, III. 1944 *K*.

Le: Mt. Hermon, Env. of Shibah, X. 1943 *K*.

***Tortula vahaliana* (Schul.) De Not.**

Ca: Without exact locality, III. 1954 *N*. S: Atlit, IV. 1954 *N*. LG: Mt Tabor, III. 1954 *N*.

***Cinclidotis aquaticus** Dix.

LJ: Env. of Sedom, VII. 1943 K.

Le: Banias, X. 1943 K.

GRIMMIALES

Grimmia orbicularis Br. Eur., c.fr.

Le: Mt. Hermon, Wadi Shibah, X. 1943 K.

FUNARIALES

Funaria convexa Spruce.

J: Battir, III. 1943 K.

Funaria dentata Crome, c.fr.

Le: Env. of Banias, IV. 1945 K.

Funaria hygrometrica (L.) Sibth.

LG: Env. of Nazareth, III. 1944 K.

EUBRYALES

***Mniobryum albicans** (Wahlenb.) Limpr., c.fr.

J: Battir, II, III. 1943 K.

Bryum torquescens, Br. Eur., c.fr.

S: Pardess Hanna, III. 1943 K. LG: Nazareth, III. 1944 K.

Le: Banias, IV. 1945 K.

Bryum caespiticum L., c.fr.

LG: Env. of Nazareth, III. 1944 K.

Bryum versicolor Br. Eur., c.fr.

J: Jerusalem, Valley of the Cross, II. 1943 K.

***Philonotis obtusata** C.M.

LJ: Jericho in a water pool, III. 1943 K.

HYPNOBRYALES

***Cratoneurum commutatum** Roth var. *eucommutatum*

Le: Northern Lebanon, VI. 1934 L.

Camptothecium lutescens Br. Eur. var. **fallax** (Philip) Brid.

J: Hebron, II. 1941 Z.

Rhynchostegium murale (Neck.) Br. Eur.

LG: Env. of Kefar Hahores, II. 1944 K.

Rhynchostegiella tenella (Dicks). Limpr., c.fr.

Ca: Wadi Shumriyeh, II, III. 1941, 1943 K; Horshat Ha'arbaim, III. 1954 N.

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